Fl. nat.
95 f

Bulletin

# BULLETIN

OF THE

# American Museum of Natural History.

Vol. VIII, 1896.

NEW YORK:

Published by order of the Trustees.

1896.

2089

BIBLIOTHECA
REGIA
MONACENSIS

WM. C. MARTIN PRINTING HOUSE
No. 111 John Street
New York

# BULLETIN

OF THE

# AMERICAN MUSEUM OF NATURAL HISTORY.

---

*Volume VIII, 1896.*

---

NEW YORK:

PUBLISHED BY ORDER OF THE TRUSTEES.

1896.

BIBLIOTHECA
REGIA
MONACENSIS

COMMITTEE OF PUBLICATION.

R. P. Whitfield. J. A. Allen.

Henry Fairfield Osborn. Wm. Beutenmüller.

F. W. Putnam.

---

*EDITOR OF BULLETIN.*

J. A. Allen.

# CONTENTS OF VOLUME VIII.


PAGE.

Title-page ..... i.

Committee of Publication ..... ii.

Contents ..... iii.

List of Illustrations ..... v.

Dates of Publication of Authors' Separates ..... vi.

List of New Genera and Species in Vol. VIII ..... vii.

ART. I.—The Changes of Plumage in the Dunlin and Sanderling. By FRANK M. CHAPMAN ..... 1

II.—On the Changes of Plumage in the Snowflake (*Plectrophenax nivalis*). By FRANK M. CHAPMAN ..... 9

III.—Alleged Changes of Color in the Feathers of Birds without Molting. By J. A. ALLEN ..... 13

IV.—Note on *Macrogeomys cherriei* (Allen). By J. A. ALLEN. (Plate I.) ..... 45

V.—On Mammals Collected in Bexar County and vicinity, Texas, by Mr. H. P. Attwater, with Field Notes by the Collector. By J. A. ALLEN ..... 47

VI.—Species of *Hyracotherium* and allied Perissodactyls from the Wahsatch and Wind River Beds of North America. By J. L. WORTMAN. (Plate II.) ..... 81

VII.—Critical Review of the Sesiidæ found in America, north of Mexico. By WILLIAM BEUTENMÜLLER ..... 111

VIII.—Catalogue of Meteorites in the Collection of the American Museum of Natural History, to July 1, 1896. By E. O. HOVEY ..... 149

IX.—The Cranial Evolution of *Titanotherium*. By HENRY FAIRFIELD OSBORN. (Plates III and IV.) ..... 157

PAGE.

X.—A Table of the Geographical Distribution of American Indian Relics in a Collection exhibited in the American Museum of Natural History; with explanatory Text. By A. E. DOUGLASS..... 199

XI.—The Temple of Tepoztlan, Mexico. By H. M. SAVILLE. (Plates V–IX.)..... 221

XII.—A Rock Painting of the Thompson River Indians, British Columbia. By JAMES TEIT. (Edited by FRANZ BOAS.)... 227

XIII.—Description of a New Genus of Fossil Brachiopod from the Lower Helderberg Limestones. By R. P. WHITFIELD..... 231

XIV.—Descriptions of New North American Mammals. By J. A. ALLEN. (Plates X and XI.)..... 233

XV.—List of Mammals collected by Mr. Walter W. Granger, in New Mexico, Utah, Wyoming and Nebraska, 1895–96, with Field Notes by the Collector. By J. A. ALLEN..... 241

XVI.—*Psittacotherium*, a Member of a New and Primitive Suborder of the Edentata. By Dr. J. L. WORTMAN..... 259

XVII.—On Mammals from the Santa Cruz Mountains, California. By J. A. ALLEN..... 263

XVIII.—Notes on Birds observed in Yucatan. By FRANK M. CHAPMAN. 271

XIX.—Transformations of Some North American Hawk-moths. By WILLIAM BEUTENMÜLLER..... 291

XX.—Notice and Description of New Species and a New Genus of Phyllocaridæ. By R. P. WHITFIELD. (Plates XII–XIV.) 299

XXI.—The Chazy of Lake Champlain. By EZRA BRAINERD and HENRY M. SEELY..... 305

# LIST OF ILLUSTRATIONS.

## *Cuts.*

PAGE.

Dorsal feathers of *Plectrophenax nivalis*, showing changes in form and color due to the wearing off of the tips ..... 10
Tip of dorsal feather of *Plectrophenax nivalis* ..... 11
*Systemodon protapirinus*, teeth, crown view ..... 87
" *primævus*, upper teeth, crown view ..... 89
*Hyracotherium tapirinum*, upper and lower teeth, crown view ..... 95
" *cristatum*, lower teeth, crown view ..... 96
" *craspedotum*, " " ..... 97
" *vasacciense*, " " ..... 98
" *index*, upper and lower teeth, crown view ..... 100
" *cristonense*, " " " ..... 102
" *montanus*, lower teeth, crown view ..... 103
*Protorohippus venticolus*, upper teeth and lower premolars, side and crown views ..... 105
*Euprotogonia puercensis*, upper premolars, crown and side views ..... 106
" *plicifera*, lower premolars, crown and side views ..... 106
*Orohippus*, sp., upper teeth, crown view ..... 108
Diagram of horn sections in species of *Titanotherium* (26 figures) ....167, 168
Evolution of the occiput in *Titanotherium* (6 figures) ..... 171
*Titanotherium torvum*, skull, side and top views ..... 176
" " " front view ..... 177
" *altirostris*, skull, side and top views ..... 180
" *trigonoceras*, " side view ..... 181
" " " side and top views ..... 182
" *platyceras*, " side view ..... 186
" " horns and nasals ..... 186
" *robustum*, skull, top view ..... 187
" *elatum*, skull, ♂ and ♀, side view ..... 190
" " " front view ..... 191
" " " top view ..... 191
" " " ♀, front view ..... 192
" *ramosum*, skull, side view ..... 195
Rock Painting, Thompson River Indians, B. C. ..... 229
*Lissopleura*, 5 figures of the type specimen ..... 232
Chazy of Lake Champlain, Valcour Island section ..... 309
" " " Isle la Motte section ..... 311
" " " Crown Point section ..... 313

## *Plates.*

Plate I.—Skull of *Macrogeomys cherriei* (Allen).
Plate II.—Upper and Lower teeth of Eocene Horses.
Plate III.—Skulls of the Short-horned Titanotheres.
Plate IV.—Skulls of the Long-horned Titanotheres.
Plates V–IX.—Temple of Tepoztlan.
Plate X.—Head of *Rangifer terræ novæ*.
Plate XI.—Antlers of Caribou.
Plates XII–XIV.—Fossil Crustaceans, of the genera *Entomocaris* and *Ceratiocaris*.

## DATES OF PUBLICATION OF AUTHORS' SEPARATES.

Art. I, March 4, 1896. Art. II, March 5, 1896. Art. III, March 18, 1896. Art. IV, April 15, 1896. Art. V, April 22, 1896. Art. VI, May 12, 1896. Art. VII, June 30, 1896. Art. VIII, July 30, 1896. Art. IX, July 31, 1896. Art. X, Oct. 26, 1896. Art. XI, Nov. 20, 1896. Art. XII, Nov. 20, 1896. Art. XIII, Nov. 20, 1896. Art. XIV, Nov. 21, 1896. Art. XV, Nov. 25, 1896. Art. XVI, Nov. 30, 1896. Art. XVII, Dec. 4, 1896. Art. XVIII, Dec. 11, 1896. Art. XIX, Dec. 16, 1896. Art. XX, Dec. 17, 1896. Art. XXI, Dec. 21, 1896.

The edition of authors' separates is 100 copies or more (frequently 150, sometimes 200 or more).

Besides the authors' separates, and in addition to the regular edition of the Bulletin, 100 copies were issued in signatures as printed, each signature bearing at the bottom of the first page the date of publication.

# LIST OF NEW GENERA, SPECIES AND SUBSPECIES DESCRIBED IN VOLUME VIII.

## Genera.


| | PAGE. |
|---|---|
| *Protorohippus* Wortman | 104 |
| *Gaëa* Beutenmüller | 115 |
| *Palmia* Beutenmüller | 123 |
| *Sanninoidea* Beutenmüller | 126 |
| *Lissopleura* Whitfield | 232 |
| *Agriocharis* Chapman | 288 |
| *Entomocaris* Whitfield | 299 |


## Species and Subspecies.


| | |
|---|---|
| *Systemodon primævus* Wortman | 89 |
| *Hyracotherium cristatum* Wortman | 96 |
| " (*Pliohippus*) *montanum* Wortman | 103 |
| *Sesia culiciformis americana* Beutenmüller | 136 |
| *Titanotherium ramosum* Osborn | 194 |
| *Rangifer terrænovæ* Allen | 233 |
| *Perognathus mearnsi* Allen | 237 |
| *Peromyscus michiganensis pallescens* Allen | 238 |
| *Vespertilio incautus* Allen | 239 |
| " *chrysonotus* Allen | 240 |
| *Entomocaris telleri* Whitfield | 300 |
| *Ceratiocaris monroei* Whitfield | 301 |
| *Ceratiocaris poduriformis* Whitfield | 302 |

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

Volume VIII, 1896.

# Article I.—THE CHANGES OF PLUMAGE IN THE DUNLIN AND SANDERLING.

By FRANK M. CHAPMAN.

One of the most interesting chapters in Gätke's notable work 'The Birds of Heligoland' is entitled 'Changes in the Colour of the Plumage of Birds without Moulting.' Herein Herr Gätke tells us that for over forty years he has given "the most unremitting attention" to this subject. As a result he presents us with three explanations of the manner in which a bird may pass from winter dress into full breeding plumage without molting. Briefly, they are the following: First, by "shedding the edges of the feathers...." Second, by "a peeling off of the separate barbs of the feathers, whereby these are stripped of a thin inconspicuously coloured envelope, so that the purer and finer colour previously concealed beneath the latter becomes exposed.....Further, the feathers, which by the end of winter were worn irregularly, and blunted at the tips, after this change of color, again have their margins completed, and their tips beautifully and evenly rounded off, so that they are in all respects like perfectly new feathers, such as would be produced by moulting." The third process is the "most wonderful," and

" consists in an actual, complete, and very striking change in the colour of the feathers, without such alteration being brought about, or even assisted, by any changes in their texture." The examples cited as illustrating this change are the Little Gull, Guillemots, and Razor-billed Auk, in which the head and neck change from white or whitish to slaty black or blackish brown ; the Dunlin, in which the upper belly changes from white to black, and other species.

The first explanation given by Herr Gätke is well known to occur in many species, and calls for no special remark in this connection. The second and third are, in part, original with him, and the evidence which he presents in their support is derived entirely from his own observations.

Probably owing to our comparative ignorance of the molt of birds and its attendant phenomena, these statements of Herr Gätke's have not only passed unchallenged, but have actually been endorsed as correct. Already we find that they have become part of the literature of general ornithology, and we read of the renewal of the worn tips of feathers and repigmentation as though they were established facts.

Herr Gätke describes in some detail the manner in which the changes of color previously mentioned occur. He does not, however, tell us just how his conclusions were reached, whether by the examination at one time of large series of specimens, or at intervals upon occasional specimens during the forty years which he has devoted to the subject. This, of course, is a matter of some importance, as every one who has studied the molt knows, and it seems to me that before accepting Herr Gätke's views they should be thoroughly tested by a study of series of specimens representing the species he mentions. As a contribution to this end I offer the following notes on the changes in plumage of the Dunlin (*Tringa alpina*) and Sanderling (*Calidris arenaria*), two species from which Herr Gätke obtained " surprising results."

The Dunlin may, I think, be quickly disposed of. It will be remembered that in winter plumage this bird is almost uniform brownish gray above, the breast is washed with the same color and indistinctly streaked with blackish, the throat and belly are

pure white. In summer plumage the feathers of the back are black broadly margined with bright rufous, somewhat lighter terminally, while the scapulars have more or less irregular subterminal black or rufous bars.

The change from winter to summer plumage is explained by Herr Gätke as follows: "In the ash-grey feathers of the back the shaft first becomes black; this color spreads rapidly over the feather, finally leaving only broad grey margins. The latter at first change to a dull rusty grey, which, however, subsequently passes into a beautiful ferruginous color. At the same time the dull ash-grey tips of the feathers pass into a whitish grey, their margins being simultaneously rounded off to their former entirety. This shows that these feathers also, which in winter are worn in such a way as to assume a lanceolate shape, undergo a renovation of structure, and that their tips do not acquire their whitish colour simply by fading. In the Dunlin this change does not extend to the long posterior flight-feathers and the smaller outer plumage of the wings, in which the colour only becomes somewhat blacker, and the margins somewhat more even, but which do not acquire the appearance of newly developed feathers, like those of the upper parts of these birds." The change in the color of the lower belly from white to black is accomplished by the third process described by Herr Gätke, mentioned above, that is by "complete and very striking change in the colour of the feathers, without such alteration being brought about or even assisted by any changes in their texture."

Whether the gray feathers become black and rufous by a chemical change in their pigment or by repigmentation is not said, but since white feathers are said by Gadow to be pigmentless, we infer that according to Herr Gätke the Dunlin's white belly becomes black by an actual influx of pigment.

Now let us see how far his claims are borne out by the series of Dunlins before me. This consists of fifty-seven specimens, of which eleven are *Tringa alpina*, while forty-six are *Tringa alpina pacifica*. Of the whole number, twenty-seven are in fall or winter plumage, and thirty are in spring or summer plumage. It is the latter series which interests us. Of these thirty birds eighteen have apparently acquired their breeding plumage. There is of course

considerable variation in their colors ; some are much blacker below and more rufous above than others, in fact the differences are of just the nature we expect to find in a series of birds in breeding plumage, and are presumably dependent upon the age and physiological condition of the individual.

The remaining twelve have not completed their breeding plumage, and are in various stages of the molt. This statement so obviously affects Herr Gätke's conclusions in regard to the change in plumage in the Dunlin that it will be well to describe some of these molting specimens in detail. The dates of capture range from April 2 to May 22 ; the localities represented are the Atlantic, Pacific and Gulf Coasts of the United States. Am. Mus. No. 29888 (So. Car., April 13, 1883, Hoxie) is just beginning to acquire the summer plumage. It has numerous pin-feathers upon the foreneck, breast and belly, the head, hindneck, back, and scapulars. Many of these new black, or rufous and black feathers are half grown, while a few are fully grown and their unworn edges are in strong contrast to the ragged borders of the gray winter plumage. Am. Mus. No. 64970 (Long Island, April 3, 1882, Dutcher) resembles the bird just mentioned, and also has numerous pin-feathers in various stages of growth upon the foreneck, breast, belly, hindneck, back, and scapulars. Am. Mus. No. 55008 (Texas, April 25, 1891, Chapman) is more advanced, being evidently at the height of the molt, and one cannot raise the plumage of any part of the body without discovering numbers of growing new feathers wrapped in their dermal sheaths. The remaining nine molting birds simply confirm what those described show, that is, that in passing from winter to summer plumage the Dunlin undergoes a complete molt of the body feathers and scapulars, but retains its rectrices and remiges.

Turning now to the Sanderling, Herr Gätke remarks that in this species "we meet with an actual threefold change of colour in the feathers of the upper parts of the winter plumage, each one of which undergoes a transition from a uniform light grey to a deep black, and from a beautiful ferruginous colour to a pure white. The black, which forms the ground colour of the feathers of the summer plumage, at first appears above their subsequently white terminal markings, and advances with increasing intensity

towards the radical portions of the feathers. Soon dull rust-coloured lateral borders are developed, side by side, with this ground colour, and a blurred spot of similar colour is formed on each web of the feathers; these spots increase in size, become purer in colour, and partially pass into transverse bands; simultaneously with these changes the dull light-grey tips of the feathers become transformed to a pure white; not, however, by mere fading, but in this case also by a restoration of the worn and blunted barbs to their previous entirety. When the change of colour is complete, the feathers are of a deep glossy black, with broad, pure white borders, and beautiful sharply defined ferruginous spots at the sides, or transverse bands of the same colour: their tips, too, which had been worn down to a lanceolate shape, have now reassumed their formal [*lege* former?] beautiful rounded form and entirety of margins. In this species the change of colour, and simultaneous restoration of the edges of the feathers, extends to the long posterior flight-feathers and outer wing-coverts."

The barred and rufous breast of the breeding bird is not described, and the breast is said to become even whiter than in winter, a statement I do not understand, but that is of no importance in this connection. I have here quoted Herr Gätke at length, because his explanation of the manner in which the Sanderling acquires its summer plumage is quite as wonderful as any statement in his chapter on 'Colour Changes.' With every desire to thoroughly and fairly test Herr Gätke's claims, I have, through Mr. Ridgway's kindness, been permitted to borrow the Sanderlings in the National Museum, and these, in connection with the specimens in the American Museum, give me a series of ninety-seven examples, representing every month in the year except July. I will therefore describe the plumage changes of this bird in some detail.

Beginning with the adult bird in full breeding plumage, the necessity for large series in studying the molt and the erroneous conclusions which may be drawn from negative evidence, is at once apparent. There is no reason to doubt that the Sanderling, like other birds, undergoes a complete molt after the breeding season, nevertheless not one of my twenty August specimens

shows any signs of molt in progress in the wings or tail. In the larger number, however, the remiges and rectrices are in an apparently fresh and unworn condition, and I assume that in most cases these important feathers are acquired before the migration is begun. This would be in July, a month which, as I have said, is not represented in my series.

Growing feathers can, however, be found in numbers upon the body as the new gray plumage slowly replaces the worn one of rufous and black, and the winter plumage is completed late in September or in October.

The young bird in the down I have not seen, but the nestling plumage is followed by the well-known plumage of the immature bird in which the back is black, each feather being terminally bordered with whitish or with two terminal whitish spots. Late in the autumn these young birds molt their body feathers and acquire a gray and white plumage closely resembling the adult. This change is shown by specimens from Yucatan, Paraguay, Aldabra Island, and other localities. In winter plumage the upper parts, including the scapulars, are ashy gray, the entire under parts pure white. A specimen collected by Herr Gätke at Heligoland, January, 1879, shows that in some instances, at least, the birds of the year can be distinguished from adults as late as midwinter by the narrow black tips of the wing-coverts.

This brings us to the change from winter to breeding plumage, which Herr Gätke, as already described, asserts is accomplished without molt.

My series of twenty specimens illustrating this change show that it begins late in March or during the first half of April and is completed in May. They show, furthermore, that it is accomplished by a molt. In proof of this statement I will describe several of these molting birds. No. 3685 (Coll. Geo. B. Sennett, Corpus Christi, Texas, March 28, 1886) is to all outward appearances in the winter plumage of the adult, but examination shows that the molt is in active progress over the entire body, in the scapulars, tertials, all but the greater series of wing-coverts, the upper and under tail-coverts. One of the median pair of rectrices is about one-third grown, while its fellow is missing. Am. Mus. No. 45485 (California, April 13, Xantus) closely resem-

bles the preceding in appearance, and like it is undergoing an active molt throughout the body and scapulars. The wing-coverts and median rectrices, however, as yet show no indications of the molt. No. 6042 (Coll. Geo. B. Sennett, Corpus Christi, Texas, April 20, 1889, Singley) is slightly more advanced than either of the birds just described. New feathers are appearing not only over the whole body, tertials, lesser and median wing-coverts, but the molt extends to the outer pair of tail-feathers, which with the median pair are about half grown. Only seven of the twelve old tail-feathers remain, and it seems probable that all the rectrices are renewed.

Am. Mus. No. 60007 (Micco, Florida, April 30, 1891; C. S. Allen) has nearly completed the molt, though new feathers are still appearing all over the body. The rectrices, tertials and lesser and median wing-coverts have apparently been renewed. Nearly all the newly-grown or growing feathers of the upper parts are broadly tipped with ashy gray, which, as numerous specimens show, is later worn off, leaving the black and rufous of the full breeding plumage.

It is evidently unnecessary to describe other specimens in this series which show the molt in every stage, and prove beyond question the manner in which the change from winter to summer plumage is accomplished.

Would that Herr Gätke's explanation of this change could be explained as easily, for in view of the large number of molting birds contained in my series of Dunlins and Sanderlings, his failure to find a single molting spring specimen is certainly a remarkable coincidence.

As further supporting my belief in the incorrectness of Herr Gätke's observations, I may add that I have examined specimens of several other species which he would have us believe acquire their breeding plumage through the same mysterious and wholly inexplicable cause to which he ascribes the changes above described in the plumages of the Dunlin and Sanderling. As a result, whenever my series has contained individuals taken at the proper season, it has clearly demonstrated that the change was accomplished by molt. Thus the Golden Plover, Knot, and other members of the order Limicolæ are shown to have a spring molt,

and while I have seen no molting specimens of *Larus minutus* the Museum possesses spring examples of *Larus atricilla* in the height of the molt.

There is evidently, therefore, urgent need for a thorough revision of this remarkable chapter on 'Colour Changes without Moulting,' and so strongly do I dissent from Herr Gätke's views, I venture to assert that his claims for changes in the color and disposition of pigment, and new growth in old feathers, will be found to be entirely baseless.

## Article II.—ON THE CHANGES OF PLUMAGE IN THE SNOWFLAKE (PLECTROPHENAX NIVALIS).

By Frank M. Chapman.

Although the changes of plumage in the Snowflake are in a general way well understood, they have not, I believe, been recorded in detail. The acquisition by the American Museum of a fine series of freshly plumaged birds taken in October, 1895, in Maine, by Mr. John Rowley, and numerous specimens collected in June, 1895, at Holsteinborg, Greenland, by Prof. L. L. Dyche, in connection with other specimens previously in the Museum, has led to a study of the changes of plumage in this species with results which seem of sufficient interest to warrant publication.

Snowflakes molt but once a year, after the breeding season. At this time the male acquires his well-known winter plumage, in which the upper parts are bordered with rusty, the cheeks, breast and sides being tinged with the same color. At first glance it would seem impossible for a bird in this plumage to assume the black and white breeding dress without molt, but a careful examination of even the extremes, that is September and June birds, readily shows how the change is accomplished, while with a connecting series each stage may be observed.

The breeding male, it will be remembered, has the whole head and neck, entire under parts, rump and parts of the wings and tail pure white, while the back and remaining parts of the wing and tail-feathers are jet black. Now if we examine the September bird we find that where the breeding bird is white the bases of its brown-tipped feathers are white, while where the breeding bird is black, the bases of the September bird's feathers are also black. This is especially noticeable on the back, and reference to the accompanying cut of a feather from the back of an October bird will at once show the distribution of black and brown.

It is not necessary to further describe the autumn plumage of so common a species, my object being to show how the change from this plumage to the breeding dress occurs. Briefly, it is through

a gradual wearing off of the brown tips, which may be a quarter of an inch in length, whereby the black or white bases of the feathers are exposed. Further reference to the feathers from the backs of October, January, March and June birds, so clearly explains the nature of this change that added remark is almost unnecessary. Not only is the apparent color changed, but the

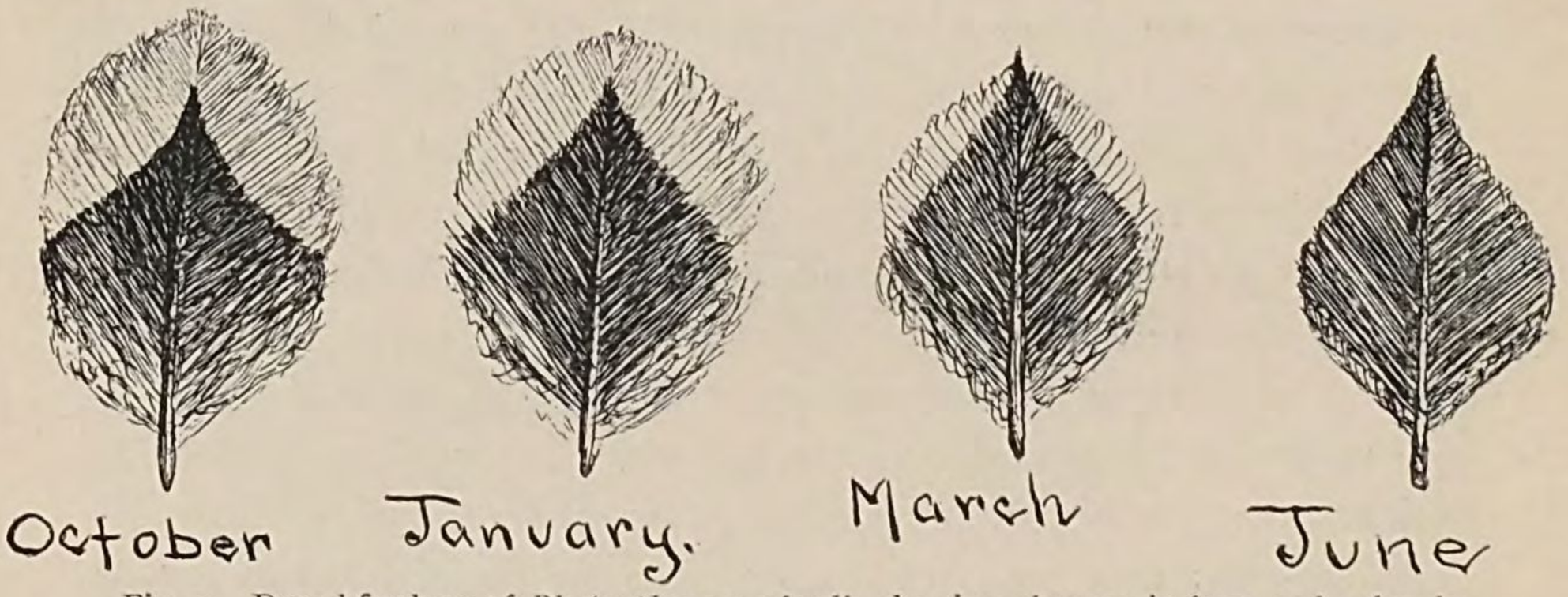



Fig. 1. Dorsal feathers of *Plectrophenax nivalis*, showing changes in form and color due to the wearing off of the tips.

shape also is altered, and in place of the rounded outline of the brown-tipped feather, we have left only its pointed, black base. The rest of the plumage undergoes a similar alteration, which in some places is evidently assisted by fading. For instance, the auriculars of September birds are brown nearly to their bases. The feathers of this region wear off only slightly, but in June birds the auriculars are pure white. There is also a fading of the brown tips themselves, and the small terminal fringe on the feathers of April birds is largely white.

The reason why these feathers in wearing off should assume a particular shape is found both in their pigment and structure. It is a well-known fact that certain pigments, doubtless in proportion to their density, give greater strength to feathers than others, and in this case that portion of the feather containing the black pigment, aside from other causes, is apparently better able to stand the effects of abrasion than the brownish or less heavily pigmented terminal portion. The strength of the black base, however, is more largely due to its structure. Examination under a low power of a dorsal feather from an October male shows that

the pointed end of the black basal area extends only to the end of the true shaft, the two barbs into which the shaft divides terminally being brownish. It also shows that at their apical portion the barbs are separated, and that the barbules do not become fairly interlocked until the black basal part is reached. This will be understood by reference to the accompanying cut of

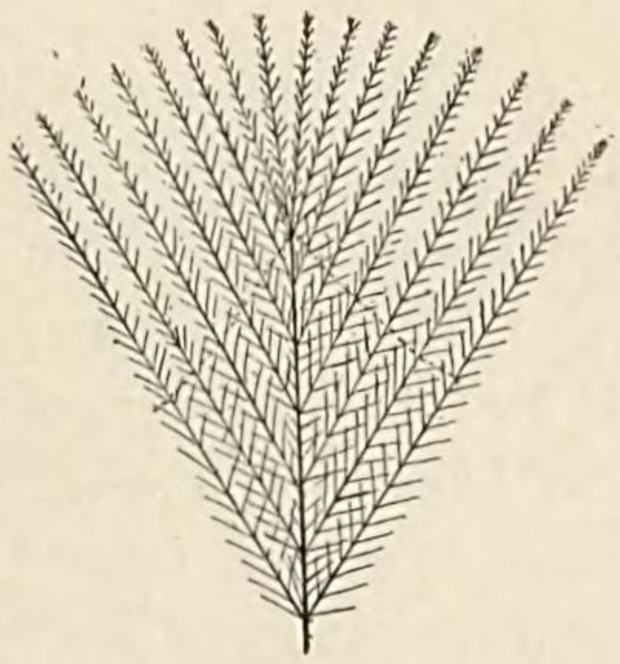


Fig. 2. Tip of a dorsal feather of *Plectrophenax nivalis*, from an October specimen. The apical portion down to the dotted line is later gradually worn off.

the tip of a dorsal feather from an October specimen. The black portion of the feather, therefore, not only is more protected than the tip, but is rendered stronger through both its pigment and structure.

Turning now to the female we find that whereas in breeding plumage she differs markedly from the male, in autumn plumage there is little apparent sexual difference. Closer examination, however, shows that the characters which so easily distinguish the female from the male in June, are also present in September, but are then largely concealed by the brownish tips to the feathers.

Thus the June female has the head, nape and rump dull blackish, not white as in the male, and when we examine September specimens we find that, aside from the difference in the wings, the sexes may be distinguished by this character; that is, the male has the feathers of the head, nape and rump basally white, while in the female they are basally black. It will also be observed that where both are black—for example, on the back—the black of the male is brighter and deeper in the autumn, just as it is in June.

But a more interesting point of difference between the sexes in breeding plumage lies in the fact that while in the male the brown tips to the feathers almost if not entirely disappear, the female retains a slight terminal fringe, which gives to her plumage a grayish cast. I cannot give a conclusive reason for this difference. There is no appreciable difference either in the length of the feather or its brownish fringe, but in the female the black center is somewhat narrower transversely, and the brownish fringe extends further down the sides of the feather, where it is evidently not so exposed. This, however, does not explain how in some feathers, for instance the tertials, the female retains a complete brownish border. The female may be less active than the male and her plumage be thus less exposed to abrasion. Still the fact remains that we have here a sexual character rendering the male more conspicuous and the female more obscure, which cannot be attributed to a fundamental sex-difference, but is made manifest through a mechanical cause.

## Article III.—ALLEGED CHANGES OF COLOR IN THE FEATHERS OF BIRDS WITHOUT MOLTING.

By J. A. Allen.

As is well known, as soon as a feather has completed its growth it merely rests on the follicle which produced it; the sheath which enclosed it while growing has fallen off; the pulp which nourished it has wholly disappeared from the base of the calamus, which is now filled with a chain of dry 'caps'; the blood vessels which supplied the growing feather with nourishment have become obliterated. The perfected feather, though worn for from a few weeks to a year, according to the species and the character of the feather, is in one sense practically a dead organ, inasmuch as it is insusceptible of further growth or repair. If its edges become abraded, or the shafts or barbs become broken, they remain so till the feather falls out and is replaced by a new one. It is to this extent comparable to a perfected leaf of a tree,[1] which, while retaining vitality for months, has not the power of self-repair; if it becomes wormeaten or otherwise mutilated, so it remains till its appointed time to ripen and fall. It may, in many cases, cling to the tree during the following winter, but when spring comes and the sap again ascends, the leaf, instead of receiving the sap and again proceeding to turn green, and to replace any parts of its structure it may have lost during the former season, is loosened from its attachment and falls to the ground, giving place to such new growth as may be destined to succeed it.

The simile of the leaf and feather is thus apposite and true. Yet if we can credit the allegations of some ornithologists the simile is far from representing what actually occurs in the case of feathers, which, it has often been claimed, as will be shown in the following pages, take on new life after a long period of rest, becoming permeated by secretions, which not only transmit new coloring matter, transforming pure white feathers into jet black

---

[1] Since writing this I find Dr. Bachmann made the same comparison in 1839, using much the same phraseology. See his 'Observations on the Changes of Colour in Birds and Mammals,' cited later. I find the same simile was also employed by Brehm in 1853, as also noted below.

ones, but solid material for restoring the ragged edges of the abraded feathers to their original size and form—in other words, transforming, just before the breeding season, the worn, faded plumage of the winter dress to the fresh, brightly, and often wholly very differently colored dress of the nesting season.

A brief account of this delusion, for such it may be justly termed, forms a most instructive chapter in the general history of the origin and persistency of error.

The assumption that birds change the color of their plumage without undergoing a molt, to the extent even of replacing one coloration by another radically different, crops out here and there at a quite early period in the history of ornithological literature, and probably dates back as a popular belief for centuries. As first expressed by the earlier writers it was little more than a belief or an opinion, advanced with little or no attempt at proof, and obviously originated in superficial or faulty observation ; while later the strong bias of an hypothesis has often blinded the observer to the real facts and conditions of the case.

The Rev. John Fleming appears to have been the first to propose and advocate the theory that "the colours of the hair of quadrupeds, and the feathers of birds, change with the season, independent of the ordinary process of *casting and moulting*," in his article on 'Hibernation' in Brewster's 'Edinburgh Encyclopædia,'[1] published in 1817. This he further elaborated and republished in 1820,[2] to which a note is appended by Professor Jameson. In the meantime the Rev. William Whitear had published a paper on the same subject,[3] in which he announced it as also his conviction that in "some birds the full-grown feathers themselves change colour, without being replaced by new ones." This opinion, he says, was based on some recent observations he had made on several different kinds of birds; a few of these 'observations' are worth quoting to show the nature of this alleged evidence. For example: (1) He says a Mr. Youell, of Yarmouth, had sixteen young wild Mallards, confined in a small pond by netting, which "put on a great deal of the beautiful plumage of the old bird, and yet that no feathers were found

[1] "Vol. XI, 1817, —" Am. Ed., 1832, X, p. 732.
[2] On the Changes of Colour in the Feathers of Birds, independent of Moulting. Edinburgh Phil. Journ., II, 1820, pp. 271–276.
[3] Remarks on the Changes of the Plumage of Birds. Trans. Linn. Soc. London, XII, pt. 2, 1819, pp. 524–526.

floating on the water or scattered on the banks of the pond." (2) He received, he says, a young wild Mallard which had nearly assumed the plumage of the adult bird; "many of the feathers were particolored, the same individual feathers retaining in some parts the color of the bird during the first months and in the other parts exposing those of the perfect bird." (3) "A male Chaffinch killed in February had the feathers of the crown of the head bluish ash-color, except at their extremities, which were rufous-brown, apparently still retaining the colour of the young bird." (4) A Reed Bunting was examined, which, in these particulars, resembled the Chaffinch; (5) the Swiss Sandpiper, the Dunlin and the Black-headed Gull are mentioned as changing color in March. Of course, the Chaffinch and Reed Bunting were changing color without molt, simply by the wearing off of the edges of the feathers, while in the Gull and Sandpipers the birds were in reality undergoing a spring molt; in the case of the Mallards, the change was also of course due to a molt, although no loose feathers were observed.

But Professor Jameson, in his note above cited, claims priority for the discovery for Captain Cartwright,[1] who, in 1792, had something to say about the changes of plumage in Ptarmigan as observed by him in Labrador, namely, that they get in fall a large addition of white feathers, "and that the coloured feathers at the same time change to white."

Dr. Fleming propounded three "laws" on the subject of the changes of the color in the plumage of birds, namely: (1) That the change in spring is from "a light to a dark colour, and that in autumn this arrangement is reversed;" (2) that the change is "regulated by the temperature of the atmosphere;" and (3) "that these changes assist in regulating the temperature of the animals in the different seasons of the year." He says he was at first inclined to believe that many species of birds must be subject to "five or six different moultings in the course of the year," but failing to find satisfactory evidence of this he adopted the view that the seasonal change of color was a true change of color in the feather—a view, as thus practically admitted, based on belief or opinion rather than on evidence.

[1] "Journal, I, p. 278."

In 1830 George Ord[1] published "some observations" on the molting of birds, in which he says: "The object of this inquiry is to ascertain whether the opinion of Temminck, that some birds change their plumage *twice* a year, is founded in fact" (l. c., p. 293). He argues that because birds suffer in health when molting, and in spring show no evidence of ill health, but are tuneful and happy, it is evident that they do not molt. He further accepts Whitear's observations and conjectures (as noticed above) as proof of change of color without molting, and further states it as a well-known fact that in male Bobolinks, kept in aviaries, "there is no change of feathers: their colours being altogether the result of organical secretions."[2] He thereupon, by a simple process of reasoning, reaches the conclusion that no birds molt more than once a year, as expressed in the following: "Is there any physical necessity, then, for *two* moultings in the course of a year?—or even *three*, as some pretend? I know of none" (l. c., p. 297).

In 1835 William Yarrell, the celebrated English ornithologist, published a paper on the same subject,[3] which, through its somewhat more scientific aspect, carried great weight and has been often quoted as offering conclusive evidence of change of color in feathers without molting. According to this author there are three ways in which changes in color are effected, only one of which, however, calls for consideration in the present connection, namely, "by the feather itself becoming altered." The most surprising part of this 'classic' proves to be the character of the evidence upon which the alleged change of color rests. Yarrell himself admits that "it is certainly difficult to understand how this is so constantly effected in the web of the feather, where no vascularity can be shown to exist even when the part is growing: but the fact is certain;....and of this fact further proof will be adduced in the course of this paper."

His evidence may be divided into two kinds: (1) His own observations; and (2) those of other persons; the latter, so far as his paper shows, being his main reliance. First, as to the evi-

[1] Some Observations on the Moulting of Birds. Trans. Amer. Phil. Soc., III, 1830, pp. 292–299.

[2] On the spring molt of the Bobolink, see p. 44.

[3] Observations on the Laws which appear to influence the Assumption and Changes of Plumage in Birds. Trans. Zoöl. Soc. London, I, 1835, pp. 13–19. An earlier abstract appears in P. Z. S., 1833, p. 9.

dence given on his own authority. He says: "Several birds examined in April were changing the colour of some parts of their plumage from that which is peculiar to winter to that of the breeding season. Many of the old feathers obtained at the preceding autumn moult still retained the colours they had borne through the winter; others were changing; and some had entirely assumed the colours peculiar to the breeding season, bearing precisely the same tints and markings as some new spring feathers, the webs of which were but partly exposed." He cites as among the birds in which this change was noticed the "Black and Barred-tailed Godwits," and "several Golden Plovers." Of the latter he says: "On the breasts of several Golden Plovers some of the feathers were entirely white, the colour peculiar to all the feathers of that part of the bird in winter; some were entirely black, being the colour assumed at the breeding season; while others bore almost every possible proportion of well-defined black and white on the same feathers; *from which it appears that the same cause of particular colour in new feathers can also partially or entirely change the colour of old ones.*" Of the *facts* as stated above there is no question, for in the perfect breeding plumage of the Golden Plover the feathers on the sides of the breast are partly black and partly white, the amount of either black or white varying with the position of the feather in the pterylæ—a fact of which apparently Mr. Yarrell was ignorant. Yet these particolored feathers are the basis of his *inference* (italicised in the above quotation) that the white feathers of the winter plumage on the breast of the Golden Plover turn black to form the breeding dress! The 'proof' in this case is of course pure inference, based on lack of knowledge of the condition of the plumage on the Plover's breast in normal breeding condition. No other evidence is here offered, his reference to the Barred-tailed Godwits being general, and probably based on that given later in the same paper at second hand.

His next and only other personal evidence is that based on the Herring Gull. In this case "Several tertial feathers were found to have their basal halves blue-grey, the other parts mottled with brown." Two of these feathers were marked at Christmas by cutting notches in them with scissors, and "re-examined in April," after an interval of nearly four months. "The tertial feathers,

which, when marked, were of two colours, were now entirely blue-grey ; one was tipped with white." In the meantime this Gull, if it did as other Gulls commonly do, underwent a complete molt of all the feathers except the quills, including what are here called "tertial feathers." Now Mr. Yarrell was either mistaken in his identification of his supposed marked feathers, or he was not. The probabilities seem to favor the first alternative.

So much then for Mr. Yarrell's personal evidence, half of which is *nil*, and the other half seriously open to question. Now as to the evidence given at second hand. First are the observations of "the Rev. Mr. Whitear and Mr. Youell," previously published (Linn. Trans., XII, p. 524), which are merely referred to in general terms as "confirming" the fact of change of color in feathers. The worthlessness of these observations having already been shown, no further comment here is required.

The second-hand evidence consists further of "the notes of James Hunt,[1] one of the Keepers, made at the Gardens of the Zoölogical Society in the Regent's Park, during the seasons of 1831, 1832 and 1833, but principally in 1832." These relate to seven species, but in reference to only four do the observations bear on the points here at issue. First is the "Black-tailed Godwit, *Limosa melanura* Liesl." In this species the change was noticed as in progress on the breast as early as the 24th of February, and on the 29th of April had extended to the "scapulars, wing-coverts and tertials," completing the change. The observations were made on a live bird, which was examined "day by day," but how closely—whether it was handled and the plumage thus examined, or only at a distance—is not stated. The importance, or rather the absolute necessity, of closely examining the plumage by raising the surface of the feathers to see what is beneath, can scarcely be appreciated unless one has made a special study of the subject of molt. It is affirmed, however, that the change "is absolutely an alteration of colour, and not produced by moulting." But excellent authorities place this species in the list of those which undergo a full spring molt, by which they acquire the colors of the breeding dress.

The next species is the Ruff, the notes on which state that the head and neck acquire a new spring plumage *by molting*, "while

[1] Published also earlier, in abstract, in P. Z. S., 1833, p. 9.

the feathers on the body were not thrown off." Nevertheless, the Ruff is thoroughly well known to molt its body plumage in spring.

The next species in point is the Herring Gull, in which "the moulting....does not appear to expedite the change of colour. The new feathers have much the same hue as those that have been shed." Yet reference is made to "a constant change of colour going on in the feathers." A spring molt, it is to be noticed, is admitted.

The fourth and only other species bearing on the question is the "Laughing Gull, *Larus ridibundus* Linn." "The feathers on the head of this Gull began to change colour from white to black on the 11th of March. It was a change of colour, and not an act of moulting; no feather was shed, and the change was completed in four or five days." As it is now well known that Gulls and Terns are among the birds that undergo a general spring molt (the flight feathers excepted), and with specimens before me of this and various other species of Black-headed Gulls, taken in spring, and showing that not only is the black head acquired by the growth of new black feathers and the shedding of the old white ones, but that the whole clothing plumage is also at the same time renewed,[1] it is evident that not much credence is to be given to these notes of Mr. Hunt on the subject of change of color in birds without molting. The birds were probably not taken in hand by Mr. Hunt and systematically examined, he simply giving his impressions of what he thought was going on as he made his daily rounds as one of the keepers of the Zoölogical Gardens.

As already intimated, Yarrell's paper has by common consent taken the position of a classic on the subject of change of color in feathers, if we may judge by its frequent citation as an authoritative utterance from which there is no appeal. Yet it is somewhat surprising to find that as late as 1884 Mr. Howard Saunders, in his 'Yarrell's British Birds,' repeats Yarrell on the Golden Plover (Vol. III, p. 272) and Black-headed Gull (*ibid.*, p. 603) without any hint that his statements are erroneous. The following sentence about the Golden Plover, from the first edition

[1] There are specimens in the collection of the Museum, showing a general spring molt, of the following species: *Larus ridibundus*, *L. atricilla*, *L. franklini* and *L. philadelphia*; also of several species of *Sterna*.

of Yarrell's 'British Birds' (Vol. II, 1839–41, p. 386), is worth quoting on account of its reappearance in the fourth edition without change, the part here italicised being of special interest in the present connection: "Some new feathers, which are obtained in the spring, are black, whilst the old white feathers of winter may be seen in change to black, some of them bearing almost every possible proportion of well-defined black and white on the same feathers, *the colouring secretions having equal influence over the old as well as the new feathers.*"

In 1837, Edward Blyth, an English naturalist of standing, made the first really important contribution to the general subject, his papers[1] giving evidence of much familiarity with the questions at issue. Yet, while aware of the fact that many birds undergo a spring molt, whereby they acquire their breeding dress, he was seriously and strangely misled into the belief that old feathers also were susceptible of change of color; apparently through not sufficiently recognizing the fact that many young birds after their first spring molt still show more or less well-marked traces of immaturity. Still some of his statements are difficult of explanation on even the hypothesis of unfamiliarity with the progressive stages of change with age, as witness the following quotations from his paper: "I had previously noticed the highly interesting fact, which had long puzzled me, that, in the same specimen, it was not unusual to perceive new feathers shooting forth in abundance, simultaneously with the most complete and surprising changes of colour in those loose, and about to be shed; and, as I knew, from observation, that many species underwent their seasonal changes exclusively in the one way or in the other, it became difficult sometimes to assign to which class such specimens should be referred. A Golden Plover, for instance, that is now before me, is every where in deep moult, renewing both its upper and under plumage; while, coincidently, most of the loose old feathers of the lower parts have changed, more or less completely, from white to black, the hue of the new feathers which are growing" (l. c., p. 261).[2] Again: "But, to return

[1] On the Reconciliation of certain apparent Discrepancies observable in the Mode in which the seasonal and progressive Changes of Colour are effected in the Fur of Mammalians and Feathers of Birds; with various Observations on Moulting. Charlesworth's Mag. Nat. Hist., I, 1837, pp. 259-263, 300–311. Also, Some Remarks on the Plumage of Birds. *Ibid.*, pp. 477–481.

[2] On the Golden Plover, see *antea*, p. 17.

from this digression to the Ducks, it will be observed that, in the latter, a varying amount of change of colour in the old feathers is a most ordinary concomitant of the assumption of the mature plumage by moult ; and the formerly disputed fact, therefore, is thus demonstrably established, that, as the secretions which colour the growing feathers also tinge those which are about to be renewed, a circulation (evidently nutrimental ; for where a bird is ailing or ill-fed, the consequences soon appear in their diminished lustre) must, consequently, obtain in feathers, even to the extreme period of their remaining attached, so that the hypothesis is unsupported by evidence which ascribes the moulting of a bird to the same cause which has been erroneously supposed to bring about the fall of a leaf ; namely, that the pores through which the fluids circulate become gradually obstructed, and that it consequently dies, and falls off " (l. c., p. 262).

Thus Blyth, in predicating that old feathers about to fall, in birds undergoing a spring molt, share the secretions, and become changed in color by them, of the growing feathers by which they are surrounded, goes far beyond the later German and French writers (presently to be noticed), who claimed that old feathers in spring become freshened and recolored to form the breeding plumage.

In 1839 the well-known American naturalist, Dr. John Bachman, contributed a notable paper on the subject of molt and change of color in birds,[1] written, largely in reply to Yarrell, Fleming, Ord, and other earlier writers on the subject.[2] While not absolutely denying the possibility of change of color in feathers, he says : " If the feathers in birds, then, which have been long stationary in their growth, are capable of receiving a new set of secretions, and of assuming opposite colours, we must seek for some new law of nature not hitherto discovered " (l. c., p. 210). His memoir abounds with valuable observations on cage birds and on fresh specimens taken in South Carolina in the spring for the express purpose of determining what species do and what do not acquire the breeding dress by a spring molt ; from which it appears that most of our Sparrows, Wrens and Warblers, so far

[1] Observations on the Changes of Colour in Birds and Mammals. Trans. Am. Phil. Soc., VI, 1839, pp. 197–239.

[2] Bachman's paper was apparently written before he had seen the article by Blyth, noticed above.

as observed, and some of the Thrushes, and various species of Gulls, Ducks, Plovers and Sandpipers, undergo a spring molt.[1] It also appears that Orioles (*Icterus galbula* and *I. spurius*), Painted Buntings, and some other species, acquire changes of color when kept as cage birds only at the season of molt.

Yet change of color in feathers without molting has been independently affirmed, and even advocated with great earnestness, by many writers during the last half century, the writings of only a few of which can be noticed in the present historical review of the subject. Dr. C. W. L. Gloger makes the claim that Audubon was the first to confess belief in a change of color without molt,[2] basing the claim on the following passage in Volume IV, p. 213, of the 'Ornithological Biography:' "Since I began to study the habits of Gulls," says Audubon, "and observe their changes of plumage, whether at the approach of the love season, or in autumn, I have thought that the dark tint of their hoods was in the first instance caused by the extremities of the feathers then gradually changing from white to black or brown, without the actual renewal of the feathers themselves, as happens in some species of land birds." Several long quotations are also made from Audubon's account of the Black-headed Gull (l. c., pp. 120–123), leading to the inference that Audubon believed the breeding dress was acquired by change of color without molt; but Audubon does not so state, much less does he offer any proof that such is the case. Yet Gloger makes these quotations the basis of a long disquisition on 'Umfärbung ohne Mauser.' Although Audubon's work was not published, says Gloger, until 1838, his studies of Gulls date much earlier, and therefore some forty years before the revival of the doctrine by Schlegel and others, in 1852, as presently to be noticed. In passing, however, it may be observed that these statements of Audubon's—a mere opinion or belief—furnish a fair sample of the 'evidence' offered by Gloger and others for a change of color without molt.

The papers of Yarrell and Blyth seem not to have been known to the German and other continental writers, who, from 1852 to

[1] Dates are given as to when the specimens were taken, and also notes as to the progress of the molt in the same species at different dates.

[2] Audubon als der erste Bekenner der Ansicht von 'Umfärbung ohne Mauser.' Journ. für Orn., II, 1854, pp. 328–334.

1856, published so much on the subject in 'Naumannia' and the 'Journal für Ornithologie.' The theory started afresh with Hermann Schlegel's address before the Altenburg Congress of Naturalists, held July 6, 1852.[1] In this paper Schlegel formulates various rules or laws respecting the season, manner, degrees and methods of molt, and the changes of color without molt, which are followed by a somewhat detailed account of the observations on which they purport to be based. Some of his 'laws' prove to have been well founded, while others were based on faulty observations, as was soon made known by various commentators on Schlegel's paper. He was not, however, the first, as he supposed himself to be,[2] to formally announce that in many species the distinctive coloration of the breeding plumage may be acquired by the shedding of the edges of the feathers of the winter plumage. Among other things, he affirmed that after feathers had reached their full maturity, they may, after a longer or shorter period of rest, by a fresh influx of secretion ('Saft') be made new, even to the restoration of their ragged edges by the formation of new barbs and new barbules. The color, he distinctly states, passes into the feathers, as well as into the bill, the feet, and the naked parts of the skin, and that it is by this process only, and not by molting, that the breeding dress in most birds is acquired.[3] The process of color change, he asserts, proceeds in many cases from the root of the feather outward, as when white, yellow or brown feathers change to black, etc.

We naturally turn to the observations on which such startling announcements rest. And what do we find? The results of microscopical examinations and systematic study of living birds? Nothing of the sort; merely off-hand assertions based mainly on the inspection of museum specimens. He takes up in systematic order the leading groups of birds, beginning with the Vultures and ending with the Ducks and other water-birds, and states how they acquire their breeding plumage. For example, to give

[1] Sendschreiben an die am 6. Julius 1852 zu Altenburg versammelten Naturforscher. Naumannia, II, Heft 2, 1852, pp. 19–40.

[2] See E. von Homeyer, Rhea, II, 1846, p. 159; Naumannia, 1853, pp. 64–78; Journ. für Orn., III, 1855. p. 113; IV, 1856, p. 129.

[3] "Zu dieser Zeit tritt auch eine grössere Menge Pigment in die Federn (wie dies auch in dem Schnabel, den Füssen und den nächsten Theilen der Haut stattfindet). Durch diesen Prozess nun, und nicht durch die Mauser entsteht das vollkommene oder Prachtkleid der meisten Vögel."—Naumannia, II, Heft 2, p. 22.

a free translation: "*Catharistes papa.* The young bird, as is known, is grayish brown-black. In this species the beautiful gray-yellow and the other colors of the old bird arise through change of color without molting. At this time appear the bright colors of the naked parts" (l. c., p. 24).

Again he says: "The origin of the breeding dress through color change (Verfärbung) I have observed in many species of the genus *Icterus.* In the following was this appearance especially striking. *Ict. icterocephalus* is yellow-gray when young with a yellow throat, black with a yellow neck and head when adult. In specimens in transition this color change is clearly seen. The black head and back of *Ict. baltimore* is wholly obtained through the change of color in the feathers without molting. *Ict. spurius* is yellowish below and green above when young, but changes to black, with reddish brown lower back, shoulders and lower belly. This color change is entirely due to change of color in the feathers without molting, the black appearing first at the base of the throat feathers, and later, like the reddish brown, spreads over the other parts" (l. c., p. 25).

Again: "In the species of *Cœreba* the change in color without molting from the greenish dress of the young to the full blue and black dress of the adult is easily seen."[1]

This is a sample of the proof offered in support of his statement that the breeding dress in most birds is acquired by a change of color in the plumage without molting! There is running comment of a similar character respecting several hundred species. The above is doubtless enough to show its utter worthlessness. He has simply looked at birds in transition stages of plumage and mistaken the intermediate phases as proof of an actual change of color without molt; whereas by means of large series of specimens, as in the cases above cited, as well as in countless others, the change from one phase to another can be traced through specimens that were actually molting when taken.

A few months later Dr. E. F. von Homeyer replied at length[2] to Schlegel's remarkable paper, premising that it contained much

[1] In the collection of this Museum are many specimens of various species of this group, taken while in molt, and showing feathers of the adult plumage in all stages of growth appearing in the immature greenish dress.

[2] Ueber den Federwechsel der Vögel; mit Rücksicht auf H. Schlegels Sendschreiben an die Ornithologen-Versammlung zu Altenburg. Naumannia, Jahrgang 1853, pp. 64–78.

that was true and much that was new, but that he had important reasons for believing that not all that was new was true, and that not all that was true was new.[1] Dr. Homeyer takes up Schlegel's ten laws or propositions seriatim, commenting on each, approving some, qualifying some and rejecting others. This is followed by critical comment on individual species, chiefly European, in rebuttal of statements by Schlegel. In the present connection we are interested mainly in Homeyer's position on the subject of change of color in feathers without molting. Such changes as Herr Schlegel claims, as from white to black, etc., he says he has never observed in any bird, and until it has been proved to take place in some particular species he shall maintain that it does not occur. He recognizes only such changes as are due to the wearing off of the edges of the feathers, and the slight changes due to exposure to light and atmospheric influences. He then proceeds to remark upon many of the commoner birds of northern Germany, which he has carefully studied in life, with special reference to the molt, correcting many of Schlegel's false statements in regard to particular species, and instancing numerous birds which acquire their breeding dress by a spring molt.

Homeyer concludes his paper by formulating his own conclusion on the general subject of molting and color change in feathers. Respecting the rejuvenation or 'Nachwachsen' of the feathers, he says that no growth takes place that is not uninterruptedly continuous from the molt. A later occurring period of growth after the maturation of the feather is beyond imagination and contrary to the whole course of nature.[2]

Dr. C. W. L. Gloger continues to believe in the change of color and in the regeneration of feathers in spring without molt. In one[3] of his several papers on the subject he says that many birds fail to acquire in the fall the full colors of their perfect plumage, the deficiency being supplied in the spring by a new influx of nourishing secretion and pigment![4] Not only this, but the abraded

---

[1] "Dieselbe enthält allerdings viel Richtiges und viel Neues; indessen habe ich gewichtige Gründe, weder alles Neue für richtig, noch alles Richtige für neu zu halten" (l. c., p. 65).

[2] "Ein Stillstand oder ein Absterben des Gefieders und ein später eintretendes Nachwachsen ist undenkbar, und mit dem ganzen Wesen der Natur—wo es überall keinen Stillstand gibt—im grellsten Widerspruche" (p. 77).

[3] Zur Erklärung der Verfärbung des Gefieders. Journ. für Orn., I, 1853, pp. 268–276.

[4] "Das hieran Fehlende wird im Frühjahre durch neu eintretendes Zuströmen ernahrender Säfte und färbender Stoffe nachgeholt" (p. 270).

edges of the feathers are restored by a renewal of the lost portions!'[1] These ideas are elaborated at length, but wholly on hypothetical grounds.

Pastor Chr. L. Brehm follows with a paper[2] in the same journal which forcibly supplements that by Homeyer already noticed, and in which he vigorously attacks Schlegel's 'Verfärbungstheorie,' and incidentally exposes the erroneous observations of Herr Leopold Martin on the change of color in the Scoter.[3] Brehm calls attention to the fact that the spring plumage is acquired in many birds through a spring molt. He considers Schlegel's belief that an old feather can increase its size and build out its broken edges as a strange assertion; a feather being like a leaf of a tree in that when once grown it cannot alter its size or form by the addition of new substance. Also, he says, no bird can pass from the plumage of the young into that of the adult through a simple change of color without molting. Such a change he declares to be simply a physical impossibility; in support of which he offers, not speculation and theorizing, but facts derived from direct observation in the field of what birds actually do.

Later Herr Brehm returns to the subject in a paper on the relationships of the Blue-throated Warblers (genus *Cyanecula*) and their molts.[4] These species molt in northeast Africa in February and March, by which process they acquire their breeding dress, and in no way by a change of color in the feathers themselves ("keineswegs aber durch Verfärbung"). When the new feathers first appear they are dull in color, lacking the brilliancy of tint they acquire later. This is due to a gray border which soon wears off—a color change long known to him—giving place to the lustre and brilliancy of the perfect breeding dress.

Brehm later writes of the changes of plumage in the Terns,[5] based on a large series of specimens collected by his son Alfred

---

[1] "Auch findet hierbei, oft sehr sichtlich, eine mehr oder weniger bedeutende Erweiterung der Federränder, mithin eine theilweise Erneuerung derselben durch Fortwachsen Statt. Ins Besondere können auf diese Weise die jüngeren Vögel ihr so genanntes erstes Herbstkleid zum nächsten Frühlinge in das vollkommene ('ausgefärbte') der älteren verwandeln" (p. 270).

[2] Gegen Schlegels Meinung über die Verfärbung des Gefieders. Journ. für Orn., I, 1853, pp. 347–351.

[3] Zur Verfärbung des Gefieders, namentlich bei *Anas nigra* [*Oidemia nigra*]. Journ. für Orn., I, 1853, p. 208.

[4] Zur Sippe der Blaukehlchen (*Cyanecula*) und deren Mauser. Journ. für Orn., II, 1854, pp. 33–36.

[5] Verfärbung und Federwechsel der europäischen Seeschwalben. Journ. für Orn., II, 1854, pp. 317–321.

in Africa. He traces the changes from the first or nestling plumage to the adult, showing how and when the various stages are acquired, and that each stage or change of plumage is due to molting and never to color change in the feathers themselves. After a review of the facts in the case, as shown by his specimens, he states that there is no room for doubt that Schlegel's 'Verfärbungstheorie' is entirely groundless.

Another contemporaneous contributor to this lively discussion is A. Hessler, who writes on the changes of color in various tropical and other Finches,[1] as observed by him for many years in confinement, in opposition to Dr. Schlegel's theory that the full breeding dress of the males is due partly to a change in the form—through a later aftergrowth (Nachwachsen)—and partly to a change of color in the feather itself without molting. While in these birds the color may be heightened by the well-known process of the wearing off of the edges of the feathers, the long tail feathers of certain of the species can be produced only by molting.

Herr Böck writes of the changes of plumage in the Ducks and Loons, with particular reference to the Scoter,[2] in correction of Herr Martin, and against Schlegel's theory. He had had before him large numbers of specimens taken in spring in which the fresh new feathers were coming in *en masse* without meeting with a single example showing color change in progress without molt.

Of special interest in this connection is a paper by Herr H. Gätke,[3] in which he claims to substantiate Schlegel's theory by numberless direct observations from nature, and in which he here sets forth all the wonderful things one finds in his chapter on 'Farbenwechsel der Vögel durch Umfärbung ohne Mauser' in his 'Die Vogelwarte Helgoland,'[4] published in 1892. Although he speaks in praise of Schlegel's paper in general, he differs from many of his conclusions, considering it as incomprehensible that Schlegel should attribute the change of color of the Snowbunting and some other species in spring to 'Verfärben,' instead of to the wearing away of the edges of the feathers. This method of change,

[1] Federwechsel und Farbenänderung bei tropischen und subtropischen Finken-Arten. *Ibid.*, pp. 185–187.
[2] Die Mauser von *Platypus niger* [*Oidemia nigra*]. *Ibid.*, pp. 309–311.
[3] Einige Beobachtungen über Farbenwechsel durch Umfärbung ohne Mauser. *Ibid.*, pp. 321–327.
[4] See English translation, pp. 149–164.

however, in Herr Gätke's opinion, is exceptional. In the case of *Motacilla lugubris*, of which he had had in hand hundreds of specimens in all stages of change from the winter to the breeding dress, he had never been able to find a new or half-grown incoming feather, the change being entirely due to color change without molting. Indeed, not only is there change of color in the old feathers, but a change of texture and form as well! Many of the back feathers become softer, weaker and more silky looking, and, what is more surprising, he says, the feathers become again whole-edged—that is, the barbs which had become more or less broken at the tip are again restored, so that the feather presents a regular unbroken border similar to that of a newly-grown feather in the fall.[1] This restoration extends also to the posterior wing feathers and wing-coverts. He says he was very much surprised to see this, but would not, with Schlegel, call it an aftergrowth ('Nachwaschen'). He also believes the barbs undergo a sort of scaling off process by which some parts become weaker and thinner or more silky, while, through the removal of the outer surface ('Haut oder Schale'), the color of the summer dress, which has been thus concealed during the winter, becomes perfectly exposed.[2]

He states further that he has found that changes in the external appearance of birds occur in many different ways, not only in different genera or species, but on different parts of the body of the same individual bird. He cites in illustration different examples of *Motacilla lugubris* and *Anthus littoralis*.

But in the case of *Charadrius auratus*, he says, Herr Schlegel is again wholly in error, for, instead of changing color without molting, they get their black breasts and yellow-spotted backs through change of feathers. But while he had found in spring these birds having on the breast and back the old bleached feathers of the winter plumage mixed with the more or less grown

---

[1] "Und, was wohl nicht weniger überraschend ist: diese Federn werden auch wieder *ganzrandig;* d. h. die Federstrahlen, von welchen die Spitzen mehr oder weniger abgenutzt (verstossen, abgebrochen) sind, werden wieder ausgeglichen: so, dass die Spitzen aller Strahlen wieder eine regelmässige, ununterbrochene Rundung der Federspitze bilden, ähnlich, wie die im Herbste neu gewachsene Feder sie zeigte" (p. 323).

[2] "Vielmehr glaube ich, dass dieselbe auf gerade entgegengesetztem Wege bewirkt wird; nämlich dadurch, dass in solchen Fällen, wo ausser der Farbe auch die Textur verändert wird, die einzelnen Federstrahlen ('Baarten') einer Art von Schälung unterliegen, durch welche sie eines Theiles schwächer oder dünner werden und das mehr seidenartige Ansehen erhalten: während anderen Theiles durch Entfernen der äusseren, die Färbung des Winterkleides gebenden Haut oder Schale die, schon seit Vollendung der Herbstmauser fertig darunter verhüllt gelegene Färbung des Sommerkleides sichtbar wird" (pp. 323, 324).

new feathers of the incoming summer dress, with no feathers showing change of color, he still believes that the feathers of the throat and sides of the head acquire their black color through an actual change of color without molting! In regard to *Podiceps minor*, and as he believes, in regard to many other genera, he finds Schlegel likewise in error, as he had had fresh spring specimens which were thickly clothed with still growing feathers. But in the case of *Larus minutus*, on the other hand, he had found the change from the winter to the summer dress due entirely to color change without molting. At first he could not believe it possible that the pure white feathers of the head could through simple change of color become deep black, but later he had the good fortune to receive specimens that completely disclosed the secret: in one the head was already black; the others showed the change just beginning. His account of how the change occurs deserves to be here given in his own words as one of the curiosities of ornithological literature.[1] To summarize, he says, in effect, that the winter white and gray head of *Larus minutus* changes to the black head of the summer dress wholly by a change of color in the feathers themselves without molting. The change begins in January, when there are already gray feathers on the hind head. These darken, simultaneously and little by little, becoming first dark gray, darkest along the shaft, and later clear black. At the same time the darkening extends forward on to the front of the head. Scattered feathers are at first blackish only along the apical half of the shaft, from which the color extends till the whole front half of the feather is gray; which then, little by little, turns to black, the edges of the feather changing last. But the change from the clear white feathers of the lower side of the head and throat proceeds differently, becoming black at once without passing through gray;

[1] "Der im Winter weiss und hellgrau gefärbte Kopf von *Larus minutus* verwandelt sich durch *Umfärben, ohne Mauser*, in den reinschwarzen des Sommerkleides. Die Umfärbung beginnt schon in Januar, und zwar an den, bereits grau gefärbten Federn des Hinterkopfes zuerst. Dieselben verdunkeln sich, gleichzeitig fortschreitend, nach und nach alle; sie werden zuerst schwarzgrau, an den Schäften am dunkelsten, und späterhin rein schwarz. Von dem grauen Scheitel erstreckt sich das Dunkelwerden zu gleicher Zeit auf den weissen Vorderkopf. Zerstreute Federn desselben werden Anfangs nur an der Spitzenhälfte des Schaftes schwärzlich. Von hier ausgehend, färbt sich die vordere Federhälfte erst grau; dieses Colorit verdunkelt sich nach und nach, und wird sodann völlig schwarz: am spätesten an den Seitenrändern der Federn.—Ganz anders geht aber die Umfärbung der rein weissen Federn an der Unterseite des Kopfes und der Kehle vor sich. An diesen Theilen tritt nämlich *sogleich*, *ohne* einem *Uebergang durch Grau*, die rein schwarze Farbe auf: und zwar an den *Spitzen* der Federn zuerst, als ganz feiner Saum. Dieser geht bald in ein halbmondförmiges Endfleckchen über, welches, sich wurzelwärts vergrössernd, nach und nach die ganze Feder mit Schwarz bedeckt" (pp. 326, 327).

the black begins at the tip of the feather first, as a lunate terminal spot, which extends gradually towards the root of the feather, until the whole feather becomes black. The change begins at the lower border of the hood and extends upward toward the bill till the change is completed, the chin feathers being the last to turn black.

With our present knowledge that the change of color is produced by a spring molt, and that not only the feathers of the hood are molted in spring, but also the whole clothing plumage, such a description as the above seems simply incomprehensible. It certainly indicates the untrustworthy character of Herr Gätke's investigations where even merely a simple matter of observation, or alleged observation, from specimens is concerned, to say nothing of more abstruse matters, where much is necessarily open to uncertainty, as for example, the varied phenomena of bird migration.

Gätke's remarkable paper did not pass unnoticed by other investigators, sharing with Schlegel's much unfavorable criticism at the hands of several subsequent contributors to the discussion. Dr. Eugen von Homeyer returns to the subject[1] in the January, 1855, issue of the 'Journal für Ornithologie.' The same volume also contains a very important paper by W. Meves[2] on color changes in birds through and without molting, in which he gives the results of his investigations on the changes of color in Swedish birds, with special reference to Schlegel's theories upon the subject. He considers first the general question of molt, and then that of color change without molt, and finally, in a supplemental note, expresses his dissent to some of Gätke's remarkable statements.

Meves recognizes: 1. A single complete molt—the fall molt, common to all birds towards autumn, whereby all of the wing and tail feathers, as well as all of the clothing feathers, are renewed. Under this heading he gives a list of the genera and species which have only this single complete annual molt. This table includes nearly all of the Fringillidæ, the Alaudidæ, Corvidæ, Kinglets, Wrens, Titmice, Nuthatches, Swallows, Shrikes, Woodpeckers, Cuckoos,

[1] Ein ferneres Wort über das Ausfärben. Journ. für Orn., III, 1855, pp. 113–117. See also, Noch ein Wort über die Verfärbung. *Ibid.*, IV, 1856, pp. 129–132.

[2] Ueber die Farbenveränderung der Vögel durch und ohne Mauser. *Ibid.*, III, 1855, pp. 230–238, pll. ii, iii. Translated, with additions, from the Oeversigt of K. Vetenskaps. Akad. Förhandl., 1854, No. 8.

Swifts, Birds of Prey, Pigeons, Herons, Rails and Gallinules, some Grouse, some Ducks, and some Grallæ. Among the song birds not already named are many species of the genera *Sylvia*, *Saxicola* and *Muscicapa*, while some of their congeners[1] fall into the next category, namely:

2. A 'double,' second, or spring molt. This is distinguished as: (*A*) complete, including all or nearly all of the clothing feathers, and sometimes the last four wing feathers and the two middle tail feathers; and (*B*) partial; that is, only some of the feathers of the head and neck.

As this table has special bearing on what has been quoted above from Schlegel, Martin and Gætke, I transcribe in full the list, given under 2, *A*, of the birds that he has found to molt in spring.

| | | |
|---|---|---|
| Anthi. | Coracias garrulus. | Lestrides. |
| Motacillæ. | Merops apiaster. | Procellariæ. |
| Saxicola rubetra. | Tringæ. | Colymbus rufogularis. |
| Sylvia nisoria. | Phalaropodes. | Totani. |
| Sylvia cinerea. | Hæmatopus. | Limosæ. |
| Sylvia curruca. | Charadrii. | Strepsilas. |
| Sylvia hortensis. | Anas glacialis. | Uriæ. |
| Muscicapa collaris. | Sternæ. | Mormon. |
| Muscicapa atricapilla. | Lari. | Alcæ. |

Under 2, *B*, or in the division having only a partial spring molt, he places *Sylvia suecica*, *Emberiza nivalis*, *E lapponica* and *Vanellus cristatus*, and also a large number of young males, especially Linne's Passeres, in the first spring following their birth year.

3. The summer molt, after the pairing season. This again is divided into *A*, complete, and *B*, partial. The *A* section is restricted almost entirely to the Anatidæ, which molt the body feathers and sometimes part of the wing and tail feathers, by means of which the males and females assume a more or less similar dress. The *B* section includes various species of Grouse which molt the feathers of the head and neck.

[1] It appears to frequently happen that closely allied species differ in respect to whether or not they undergo a spring molt. Thus in the Charadriidæ, judging by the abundant material in the American Museum, while apparently all the species of *Chardrius* proper, and of such allied genera as *Arenarius*, *Squatarola*, etc., acquire their breeding dress by a spring molt, the more uniformly colored species of *Ægialitis* show no indications of a spring molt. Again, while the Phalaropes, the Curlews, and many of the Sandpipers molt in spring, in the Pectoral and Bartramian Sandpipers, and in some other species, large series of spring specimens give no evidence of molt.

4. A threefold ('dreidoppelte') molt, or a union of the spring, summer and fall molts. This is also divided into *A* complete, as in *Lagopus alpina* and *L. subalpina*, and *B* partial, as in the Grebes and Cormorants.

In addition to the changes of plumage produced by molt and the growth of new feathers, Meves distinguishes changes of color due to the wearing away of the edges of the feathers. This he has found, by microscopical examination, is produced in two ways—(1) through a simple falling off of the tips of the barbs; (2) through a falling off of not only the tips of the barbs, but of the barbules as well. In the first case the coloring matter in the clothing feathers of the winter plumage which have white, dark, or colorless edges, is found in the barbules and barbs; in the second case only in the barbs. These fugaceous tips begin to fall gradually soon after the fall molt, but only in spring or later do they wholly disappear and reveal the previously concealed color in its full beauty.

In order to show the very different structure of feathers of the winter and summer plumage in some birds which have a double molt, he gives numerous figures, which he hopes will have some influence against the views of Schlegel and others who believe that one plumage can be transformed into another without molt.

In 1856 Dr. D. F. Weinland published two short papers on the subject of change of color in feathers without molting.[1] They are of interest mainly from the historic point of view, since they contain an original suggestion that later met with some favor. He accepts as a fact, to begin with, the change of color in feathers claimed by Schlegel and his followers, and considers the question, "how can a feather change its color, when its blood-vessels and nerves are dried and dead, as is the case with every feather soon after it has reached its full growth" (Proc. Boston Soc. Nat. Hist., VI, p. 35). He refers to the bleaching of specimens in museums, and to the fact that some birds, as the Merganser (*Mergus merganser*), soon lose after death the rosy tinge which in life pervades the plumage of the breast. He states that on examining a feather thus colored, taken from a freshly-killed bird, under a high

[1] Zur Verfärbung der Vogelfeder ohne Mauserung. Journ. für Orn., IV, 1856, pp. 125-129. The Cause of the change of Color in the feathers of Birds, and in the hairs of Mammalia, and the manner in which this change is effected. Proc. Bostor Soc. Nat. Hist., VI, 1856–59, pp. 34–37.

power of the microscope, he "found all the pinnulæ filled in spots with *lacunes* of a reddish fluid, which....seemed to be of an oily character." Some weeks afterwards the same feathers, having been exposed to light, had become nearly white, and "instead of the reddish *lacunes*, only air-bubbles, which it is known produce a white color," were found. The evaporation of this reddish fluid, and its replacement with air-bubbles, he concluded produced the change of color. After rejecting as "unphysiological" the well-known fact that change of color is often produced by the wearing away of the edges of the feathers, he proceeds to formulate the following hypothesis, to account not only for the change of color in birds in acquiring the breeding dress, but also the changing to white in winter of many northern mammals and birds, and the sudden change to gray or white of the hair in man and the mammalia, or the feathers in birds: "If this fluid is an oily matter, as there is reason to suppose, it will be readily admitted, physiologically, that it may be furnished by the organism, by imbibition through the tissues, in consequence of a certain disposition of the nerves leading to the skin, (even if the vessels and the nerve in the feather itself should be dried,) for fat goes through all tissues without resistance, and also through horn. Thus the fat coloring matter may flow into the feathers during the time of reproduction, which is the richest season in every living organism; and then again, from want of food, cold temperature, weakness, decrepitude, or from strong emotions of the central nervous system, from sudden terror or grief,—the same coloring fat may be called back to furnish the suffering organism" (l. c., p. 36). The same hypothesis is stated, but in less detail, in his paper in the 'Journal für Ornithologie' (l. c.), which, however, in other respects is a quite different paper, dealing somewhat at length with the probable or supposed influence of climate upon seasonal change of color in mammals and birds.

As will be seen later, the idea underlying Weinland's hypothesis was subsequently elaborated in great detail as an original theory by Victor Fatio.

In 1863 N. Severtzof published a paper which, from its title,[1]

[1] Mikroskopische Untersuchungen über die Verfärbung der Federn zum Hochzeitskleide bei einigen Vögeln, nebst Betrachtungen über das Verhältniss derselben zur Mauser. Bull. de l'Acad. Imp. des Sci. de St. Pétersbourg, VII, 1863, pp. 330–346.

one would naturally expect to contain most important information. It proves, however, quite otherwise, consisting of hypothetical explanations of well-known phenomena. He makes few direct references to the literature of the subject, beyond an allusion in general terms to Schlegel, whom he calls the first discoverer of 'Verfärbung.' He states, however, that so far as he had read, no one had previously made use of the microscope in such investigations[1]—an omission he proposes to supply. He bases his investigations primarily on a series of spring specimens of *Vanellus gregarius* (=*Chettusia gregaria*) taken on the Ural River. This series consisted of birds in various stages of transition from the winter to the breeding plumage, which seemed to him to 'point to' color change in the old feathers. Examination under the microscope of a much variegated specimen, taken in April, and showing every stage of color change, convinced him that 'Verfärbung' was indeed an actual fact, although in the feather itself no vital process was taking place, the phenomenon being purely physical, and such as may occur even in a dead feather so long as it is attached to the skin, or indeed in a stuffed cabinet specimen.[2] This physical process is simply endosmosis.[3]

The *modus operandi* of the process is thus explained. He conceives first the existence of a coloring fluid, which enters the feather from the body. From the general context it would seem that he supposes the fluid to be part of the natural juices of the body, but near the close of the paper (as will be noticed later) he states that the pigment is set free from the blood, but in what way it becomes separated he fails to clearly state. At all events, under his hypothesis there is a supply of this colored secretion somewhere in the tissues of the body at the base of the feather, and this colored fluid, at the time when the dry dead feathers ('die schon trockene und abgestorbene Feder') of the autumn plumage are to be transformed into the fresh brightly colored breeding dress, it enters by endosmosis through the base of the feather and ascends, by the laws of capillarity, between the walls

[1] He must have overlooked Meves's important paper, published, as noted above, in 1854.

[2] "Ich untersuchte dieselben unter dem Mikroskop: es ergab sich, das die Verfärbung wirklich stattfindet, dass aber in der Feder selbst kein Lebens-, sondern ein rein physikalischer Process vor sich geht, der also auch an der abgestorbenen Feder möglich ist, so lange sie an der Haut haftet (was jedoch nicht unbedingt nöthig ist)" (l. c., pp. 331, 332).

[3] "Meine Beobachtungen umfassen drei Arten von Verfärbung, denen derselbe physische Process, die Endosmose, zu Grunde leigt: (1) normale Frühlingsverfärbung der lebenden Vögel; (2) anomale Sommerverfärbung derselben; (3) Verfärbung der todten Bälge. Diese drei Arten der Verfärbung erklären sich gegenseitig" (l. c., p. 332).

of the quill and the 'medulla,' reaching the vanes and passing on from cell to cell through the barbs and barbules to their extremities,[1] and even sometimes exuding from their broken tips. In this way the old feather is rejuvenated, taking on all the freshness of a newly-grown feather.[2] As this fluid dries the new pigment is deposited in successive layers on the cell walls within the feather. In the feathers of the lower body the drying is less complete than in those of the head; in the former this coloring fluid is merely concentrated by evaporation to about the consistency of a saturated solution of gum. The drying is gradual, and is not completed till the process of color change is fully ended.[3] He admits that it is not quite clear to him how in mottled and particolored feathers the pigments are able to arrange themselves so as to form the different patterns of color-marking, but he believes it is due to bleaching and abrasion, and is conditional upon the structural differences that characterize different parts of the feather.

In regard to the origin of this color-bearing fluid, his explanation is brief and unsatisfactory. He reiterates near the close of his paper the statement that the color change in a feather is a purely physical and not a vital process. But in the skin, which is not dead, the process is vital, and is similar in character, and only differs in degree, from the formation of new feathers. The pigments set loose in the 'blood plasma' are in some way separated and enter the feathers in the manner already described.[4]

---

[1] "Die Färbende Flüssigkeit dringt endosmotisch durch die Federbasis und steigt, nach den Gesetzen der Capillarität, zwischen den Wänden der Federröhre und der Medulla auf" (l. c., p. 333).

[2] "Unter den Mikroskop ist noch etwas zu sehen, was die Richtigkeit meiner Erklärung beweist: Pigmentausschwitzungen an den Spitzen der abgeriebenen Barbillen und verstossenen Federbärte. Eben diese Ausschwitzungen verursachen die Erscheinung, dass die verfärbte Feder dem blossen Auge wieder eben so frisch erscheint, wie eine neugewachsene" (l. c., pp. 334, 335).

[3] "Diese Flüssigkeit trocknet im Gefieder des Leibes nach und nach schichtweise auf der inneren Seite der Zellenwände; aber es sind viele Schichten nöthig, um jede Zelle, also auch die ganze Feder, vollständig zu färben.... Auch ist das schichtweise Trocknen der färbenden Flüssigkeit in den Zellen der Unterleibsfedern nicht als vollständiges Trocknen zu verstehen, sondern als Concentration durch Verdampfen etwa bis zur Consistenz einer gesättigten Gummilösung. Vollständig trocknet die Feder im Frühjahr erst nach geschlossenem Verfärbungsprocesse" (l. c., pp. 334, 335).

[4] "Kehren wir nun zur Verfärbung durch Saftzufluss zurück. Diese Verfärbung der Feder ist, wie gesagt, eine rein physikalische, keine Lebenserscheinung. Aber in der Haut, die nicht abstirbt, ist dieser Saftzufluss eine Lebenserscheinung, dieselbe Erscheinung, welche, nur in stärkerem Grade, auch bei der eigentlichen Mauser vorkommt. Bei einem schwächeren Saftzuflusse findet Abscheidung von Pigment statt,welches wohl im Blutplasma aufgelöst war und in der beschriebenen Weise in die shon vorhandenen Federn dringt. Bei einem stärkeren Saftzuflusse ist Neubildung von Federn bedingt, welche die alten verdrängen (normal), oder zwischen ihnen wachsen (Halskrausen des Kampfhahns und des Kragentrappen). Den Uebergang beider Processe in einander habe ich, wie gesagt, bei *Limosa melanura* beobachtet, so dass irhe wesentliche Einheit nicht bloss eine theoretische und abstracte, sondern eine concrete, thatsächlische ist" (l. c., p. 345).

That he is here grossly in error from a physiological standpoint need not be urged. His statement of the similarity of origin of his supposed coloring fluid, which enters the feather by a "purely physical process," with the formation of a new feather, is too obviously absurd for serious consideration.

It is unnecessary to follow his elaborate descriptions of the various alleged steps in the process of color change in the feathers ; suffice it to say that they are as detailed and similar in character to those given by Gätke for the Sanderling and other species, and doubtless have scarcely more basis in fact. As already said, his investigations are based primarily on *Vanellus gregarius*, but include also *Limosa rufa*, *L. melanura*, *Tringa subarquata*, *T. variabilis*, *Numenius arquata*, and *Fuligula rufina*— all species that are known to acquire their breeding dress by a spring molt. In the genus *Limosa*, however, the spring molt is often only partial, many of the feathers of the winter dress being retained, while others are replaced by new ones.

In 1866 Victor Fatio published an extended memoir[1] on the structure and coloration of feathers, reviewing briefly the work of previous writers in the light of his own investigations. He treats the subject under five headings, as follows: I. De la structure des plumes (pp. 251–261); II. Des mues réelles ou par renouvellement (pp. 261–265); III. Coloration et mue ruptile (pp. 265–282); IV. Développments parallèles des plumes et des couleurs (pp. 282–298); V. De la décoloration (pp. 298–305). His paper calls for notice here mainly on account of his peculiar views on the manner in which changes of color occur in feathers without molt. He very truly says at the outset that when the feather has completed its growth it has received all the coloring matter it can ever obtain from the body. The blood vessels then become obliterated, the creative lymph gradually disappears, the inferior umbilicus is closed by an operculum, the now useless sheath falls away in little flakes, and the pulp which constituted the life of the feather dries up from the summit to the base. The feather having completed its development falls into a state of apparent death, receiving nothing more directly from the

[1] Des diverses modifications dans les Forms et la Coloration des Plumes. Mém. de la Soc. de Phys. et d'Hist. Nat. de Genéve, XVIII, Pt. 2°, 1866, pp. 249–308, pl. i–iii.

body.[1] Through exposure for a greater or less length of time to external influences, it progressively deteriorates, and later falls, pushed out by the new feather which comes to replace it. A feather once dry receives no longer any blood or pigment from the body.[2]

Yet Fatio admits an almost constant change in the color of the mature feathers, and it is of interest to examine what he says of how it is brought about, and his evidence of the existence of such change. The changes, he says, may be effected gradually with the advance of autumn, or, with the approach of spring, declare themselves much more rapidly. The first, he says, is illustrated in the Starling and in some Finches; the second, frequently so sudden, is seen in the new coloration of some parts of the plumage of certain birds, as in the hood of *Larus ridibundus!* And here comes to light again the old case published by Yarrell—already noticed at length in this paper—which seems to have instigated Fatio's whole assumption of a radical and rapid change of color in feathers.[3] As already shown, he disagrees radically with Schlegel, who, he says, "n'émettait qu'une pure hypothèse" when he explained the change of color at the approach of the breeding season by a renewal of life in the feather, with the transmission into it of blood and pigment. But Fatio appears to have emitted an equally pure hypothesis to account for supposed changes of color in feathers, for many of the phenomena he attempts to explain are purely imaginary, as especially those in Chapter V, 'De la décoloration.' Believing strongly in a change of color in feathers, and also that they are practically dead organs capable of receiving nothing from the body after they have matured, he conceived the idea that fat, derived from the bird's body, penetrates the structure of the feather and acts as a solvent for the pigment con-

[1] "Plus tard les vaisseaux sanguins se sont oblitérés, la lymphe créatrice qui a subsisté encore quelques temps a disparu petit à petit, l'ombilic inférieur s'est couvert d'un opercule, la gaîne inutile est tombée par feuillets jusqu'au niveau de la peau, et nous voyons alors que la pulpe constituant l'âme de la plume s'est peu à peu desséchée, du sommet à la base, mais d'une manière plus ou moins complète suivant les différentes plumes. La plume qui a fini son développment est tombée dans un état de mort apparente, et, quoique bien souvent elle ne reçoive plus rien directement du corps, nous verrons qu'elle n'en est pourtant pas complétement indépendante" (l. c., p. 260, 261).

[2] "La plume une fois desséchée ne reçoit plus ni sang ni pigment du corps, pas plus qu'elle ne croît encore par sa base" (p. 266).

[3] "....et nous voyons un exemple du second dans l'apparition, souvent si prompte, d'une nouvelle coloration pour quelques parties du plumage de certains oiseaux, comme dans la calotte du *Larus ridibundus*. Tandis que beaucoup de plumes sout renouvelées au printemps à la tête de ce Larus, plusieurs passent, en effet, très-vites du blanc au brun, en peu de jours même, comme Yarell [sic] affirme l'avoir observé" (l. c., p. 267).

tained therein, he being led to this by sundry primitive experiments of his of soaking feathers in oil. Through the supposed action of fat, moisture, light, heat and cold, either separately or variously combined, he attempts to account for a wide range of color changes, either real or imaginary, but mainly the latter. Yet he discards Weinland's hypothesis of the passage from the body into the feather of a colored fat capable of tinting the feather, and also Severtzof's supposition of an extraneous foreign principle, 'l'ozon,' which penetrates the feather and dissolves in it the pigment, and which then, through a process of endosmosis, colors all its different parts. Without taking space here to refer in detail to his experiments, explanations and arguments, we may give the gist of his conclusions in the following extract: "Ainsi donc, sous l'influence, d'abord d'une humidité tour à tour absorbée et évaporée, comme agent développant préparateur, puis de la graisse du corps comme dissolvant, puis enfin de la température et de la lumière comme agents facilitant les actions chimiques, la plume se colore, change ou augmente sa coloration" (l. c., p. 279).

The action of humidity, in his hypothesis, plays a minor but important part in expanding the cortical substance of the feathers, the chief rôle being that of the fats from the body, which by some means, either external or internal, gain access to the pigment granules and dissolve them, so that the coloring matter is, at least hypothetically, held for the most part in solution, subject to extravasation, to transportation, and even to decoloration. As, however, his treatment of the subject is for the most part in generalities, and from a purely hypothetical basis, and as his illustrations are often obviously malapropos—changes of coloration well known to be brought about by molt being cited as illustration of changes of color without molt—his conclusions seem scarcely entitled to serious consideration. Nor do they appear to have made a very profound impression upon the literature of the subject.[1]

Since 1866 little has appeared on the subject of change of color in feathers. Although the erroneous character of the theories and opinions of Schlegel, Gloger, and Gätke was soon made thor-

[1] We do not refer here to his earlier chapters, which, although tainted with his hypothesis of the solution and transformation of the coloring matter of feathers, are, for the time, important contributions to our knowledge of the growth and structure of feathers.

oughly evident, similar beliefs have still a firm lodgement in the minds of many writers of the present day. Not only has Herr Gätke republished his early absurd views within the last few years, but similar notions appear to have arisen independently among those who have perhaps never read either Schlegel's or Gätke's papers, or the later memoirs of Severtzof and Fatio.

And now comes the exceedingly unpleasant duty of instancing a few modern cases of belief in the addition of pigment, and its free movement, in old feathers. A conspicuous instance is of course Mr. Charles A. Keeler,[1] who believes that pigment "travels through the various branches of the feather, advancing farthest and most rapidly along the lines of least resistance and accumulating in masses where the resistance is greatest," etc. (l. c., p. 159). In other words, the inference is fairly deducible that the feather first grows and is then decorated, and may also change color by "an addition of pigment without moult."

Mr. F. W. Headley[2] evidently accepts a somewhat similar view, as he says: "A far more remarkable cause of change of colour [than the shedding of the tips of the feathers] is the entrance of fresh colouring matter into the feather, which cannot therefore be an entirely dead thing. This is what takes place when the Blackheaded Gull puts on his spring head-dress, the colour, according to Gätke [!], appearing first at the edges of the feathers and gradually extending till the whole is dyed. In winter the breast of the Dunlin is almost white, in spring it becomes black, the pigment working its way to every part of the feathers through channels as yet undiscovered. By a similar process the head of the Little Gull changes in spring from white with a dash of ashen-gray to black," etc. (l. c., p. 160).[3] To show how little Mr. Headley really knows of the subject of which he is here writing, it is sufficient to say that these and all the other species he mentions in this connection, as the Knot, Wood-sandpiper and Herring

[1] Evolution of the Colors of North American Land Birds. 8vo, San Francisco, 1893.

[2] The Structure and Life of Birds. Sm. 8vo, London, 1895.

[3] Mr. Headley is evidently not the only one who has been dazed or misled through lack of familiarity with the subject, by Gätke's strange statements. Thus a writer in 'The Auk' (XII, 1895, p. 346) alludes to Gätke's researches in the field of 'aptosochromatism' as an "extremely valuable" contribution to the subject, and proceeds to approvingly enumerate its leading points. Also a reviewer of Gätke's work in 'The Ibis' (Jan., 1896, p. 142) refers to the chapter "relating to colour changes without a moult" as "perhaps the most valuable chapter in the book"! In this relation attention is called to Mr. Chapman's paper (*antea*, pp. 1–8) on 'The Changes in the Plumage in the Dunlin and Sandpiper,' written apropos of this particular chapter in Mr. Gätke's book.

Gull, are birds that have long been known to acquire their breeding dress by a spring molt.[1]

It is even more surprising to find men of the scientific standing of Dr. R. Bowdler Sharpe asserting that the striped plumage of the young Sparrow Hawk (*Accipiter nisus*) becomes changed to the barred plumage of the adult through "a gradual change in the markings of the feather, and not by an actual moult,"[2] or that *young* Wagtails (*Motacilla lugubris*) gain their first full spring plumage by a molt, while the old birds of the same species do *not* molt in spring, but acquire gradually the black on the back and throat "without loss of a feather;"[3] the same being also affirmed of other species of the genus *Motacilla;* although Meves and various other writers ascribe to these birds a spring molt, through which they obtain their breeding dress.

Also that Mr. W. R. Ogilvie-Grant should assert that the female Red Grouse (*Lagopus scoticus*) acquires its summer dress mainly by molt, but partly by a change in the spring in the pattern of the markings in some of the "same feathers which in autumn and winter" were differently marked;[4] or, as he more fully states it:

"The summer flank feathers are produced in two ways, either by the gradual rearrangement and change in the pigment of the autumn feathers or by moult. In some birds the whole of the alteration in the plumage of the flanks is produced by change of pattern in the old autumn feathers, in others the change is entirely produced by moult, while sometimes both methods are employed by the same individual. In the former case the first indication of the coming change may be observed in the beginning of the month of November, or even earlier, when many of the flank feathers show traces of an irregular buff stripe or spot next the terminal half of the shaft. As the bird only changes about half the flank feathers, these buff marks are only to be observed on such as are destined to undergo alteration of pattern, which, roughly speaking, means every second or third feather. The buff gradually spreads along the shaft, then becomes con-

[1] See, for example, Macgillivray's 'British Water Birds,' under these species, to say nothing of authorities already cited in other parts of this paper.

[2] P. Z. S., 1873, p. 418.

[3] Cat. Birds Brit. Mus., X, 1885, p. 461.

[4] Cat. Birds Brit. Mus., XXII, 1893, p. 37, footnote.

stricted and broken up into patches, which gradually spread laterally towards the margins of the webs, forming wide irregular buff bands. Meanwhile the interspaces become black, and the rufous of autumn dies out.... It may very naturally be asked why some females should change their flank feathers by moult, while others are enabled to go through the much less exhaustive process of redecorating their old autumn feathers and making them serve the purpose of new summer plumage. This is a difficult question to answer, but it seems natural to suppose that the more vigorous birds gain their summer flank feathers by moult, while nature has enabled the weaker individuals to obtain the necessary protective nesting plumage by a more gradual and less exhaustive process.'"[1]

In view of what is known of the growth and structure of feathers, and of the character and nature of pigment, such suggestions as the above are simply incomprehensible. To speak, as above, of the "redecoration" of feathers, through the "rearrangement and change in the pigment," involving both change of color and "change of pattern" in the markings, is to imply histological conditions such as no microscopist in studying feather structure has yet discovered; and not only this, but such a reorganization of the internal structure of a practically lifeless organism as is entirely opposed to the known conditions of the case.[2] On the other hand a more reasonable explanation is available. Every ornithologist of experience knows that in birds which are several years in acquiring their adult plumage, or which have a very varied and irregular pattern of markings, it is possible to find, by means of a good series of specimens, almost every imaginable stage and combination of markings, and such a connected series of gradations, as to seem to prove a continuous change in both color and markings from the younger stages to the adult by simply change of color without a molt. In other words, a given molt by no means affects all individuals alike, but carries some to a considerably more advanced stage in the series of changes than others; also, that in the case of irregular and varied patterns of color markings,

[1] On the Changes of Plumage in the Red Grouse (*Lagopus scoticus*). Annals of Scottish Nat. Hist., No. 11, July, 1894, pp. 129–140, pll. v and vi. The above extract is from pp. 135–137.

[2] The consideration of the microscopical structure of feathers, and the nature of pigment as affecting coloration, is quite beyond the scope of the present paper, respecting which the reader is referred to Dr. Gadow's well-known memoir 'On the Colour of Feathers as affected by their Structure' (P. Z. S., 1882, pp. 409–421, pll. xvii, xviii), and the papers he there cites.

it is not uncommon to find in one and the same individual, feathers, so far as their markings are concerned, which represent phases peculiar to several distinct molts. Indeed, it was just such intermediate stages, combined with hasty observation and faulty reasoning, that led Schlegel, half a century ago, to announce that nearly all birds obtain their breeding dress simply by change of color in the feathers without molting, and later misled Severtzof, and Fatio to the construction of elaborate theories to account for imaginary facts.

If one will take a good series of specimens in molt (unfortunately such specimens are rare in collections[1]), in the case of species which are alleged to, and which have the appearance of, changing color without molting, it will be found that the particolored and apparently changing feathers have this appearance when they first break from the sheath in which they are formed, and that these deceptive feathers have not necessarily acquired their peculiar appearance by a subsequent and quite inconceivable change in the amount, arrangement and character of the coloring matter.

As already shown, and as most ornithologists know, many birds do undergo great change of color without molting; but it is equally well known that this striking change in color, as from the winter to the breeding dress, is due not to any addition of pigment, or to any marked change of color in the feathers, but simply to a gradual wearing off of the light colored edges of the feathers of the winter dress, leaving, as the breeding season approaches, the already existent colors of the breeding dress exposed. Combined with this is more or less blanching of the color of certain parts. Striking illustrations of such changes are afforded by the Snow Bunting (*Plectrophenax nivalis*),[2] the Bobolink (*Dolichonyx oryzivorus*), and numerous other species that might be mentioned. In a less striking degree the change is common to nearly all single-molting birds, and also to many that undergo a second or spring molt, in which the feathers of the new dress are at first more or less dis-

[1] It is to be regretted that birds in molt are generally looked upon by collectors, and too often by ornithologists, as undesirable because not in 'good plumage,' whereas such specimens often prove to be the most valuable and instructive that can be obtained.

[2] On this species see *antea* (pp. 9-12), Mr. Chapman's paper, entitled 'On the Changes of Plumage in the Snowflake (*Plectrophenax nivalis*).' Also the same author's papers 'On the Changes of Plumage in the Bobolink (*Dolichonyx oryzivorus*),' Auk, VII, 1890, pp. 120–124, and *ibid.*, X, 1893, pp. 309–341, pl. vii.

tinctly skirted with a fringe or superficial wash of ash, buff or olive, which more or less quickly disappears, often by the double process of abrasion and fading. Exposure to the elements and friction also produce more or less marked change in color where there is no conspicuous loss of tissue from the border of the feather. Generally this is simply an obvious loss of color by fading, but in some instances the color becomes somewhat heightened, as in the case of some browns which change from a grayish brown to a more reddish tint; this may be due in part to abrasion, but probably somewhat also to chemical action consequent on exposure. In such changes, however, there is no transposition of pigment, nor any radical modification of pattern—no "redecoration," and no transformation of white feathers into black—but merely a slight change in tone.

It is noteworthy that while many writers have believed in and have advocated change of color in feathers, of even the most radical kind, the theories as to the causes and methods of the change are as diverse and as numerous as their ingenious inventors. In several instances the fat of the body has been presumed to be the vehicle of the colored secretion that is supposed to flow, by imbibition, or capillarity, or by some unknown process, from the body into the feather; in one case (Fatio) it is not a vehicle for the transportation of pigment, but merely a solvent for the pigment granules already in the feather; in another case a 'secretion' (not a fat) flows from the body into the feather and spreads by endosmose to its remotest cells, depositing in layers the pigment it carries till the feather is duly colored (Severtzof). How the supposed secretion, which mechanically (not physiologically) acts as the coloring agent becomes charged with its burden of pigment no one really attempts to explain; yet some of these theory builders do confess themselves puzzled to understand how under this mechanical or 'purely physical' (Severtzof) process the pigments can so accurately assort and arrange themselves as to produce the color patterns of variegated feathers.

While there may be a slight basis in fact for some of these speculations, if there really is such a thing as an increase in the quantity, and any radical change in the position, of the pigment in a dead feather, it is still, as stated by Bachman in 1839, by

virtue of "some new law of nature not hitherto discovered." Finally, as has already been stated in substance, the inventors of these diverse theories have assumed, and attempted to explain, conditions that in nine cases out of ten had no existence; namely, a color change, demonstrably due—normally at least—to molt, which they have supposed must happen in some other way.

**Supplemental Note on the Spring Molt of the Bobolink.**—Since the foregoing was made up for the press I have had opportunity, through the kindness of Mr. Thomas Proctor of Brooklyn, of examining *twenty-five* live Bobolinks (*Dolichonyx oryzivorus*) in the bird stores of that city, and two others in Mr. Proctor's own extensive aviary. The examination was made on the 14th of March, and the molt was in all stages, from birds showing only here and there the tip of a black feather on the breast, to those that were in nearly full breeding dress. A large number were in the highest stage of the molt, pin-feathers being distinctly visible, especially among the wing-coverts and scapulars and interscapulars, even when the birds were several feet distant. Generally the black appeared in patches scattered irregularly through the autumn plumage; on the lower parts, where the change was most striking, sometimes the black prevailed and sometimes the olive buff tints of the fall dress. In short, the birds presented the same conspicuously pied appearance seen during the molt at the end of the breeding season, except that the incoming colors were reversed, the black now replacing the autumn dress instead of the reverse.

Of course, since the publication of Mr. Chapman's papers 'On the Changes of Plumage in the Bobolink' (cited *antea*, p. 42, footnote 2), there has been little reason to doubt that the Bobolink acquired its breeding dress by a spring molt; yet as his conclusions were based on the examination of scanty material, and as there has been a tendency in some quarters to question their correctness, and as the contrary has often been asserted (see the case of Ord, *antea*, p. 16), it seems worth while to record in this connection the overwhelming proof of the fact I am now fortunately able to adduce.

# Article IV.—NOTE ON MACROGEOMYS CHERRIEI (ALLEN).

By J. A. Allen.

PLATE I.

In December, 1893 (this Bulletin, V, p. 337) I described as new a form of *Geomys* from Costa Rica, under the name *Geomys cherriei*, the description being based on a single immature specimen. The species was redescribed from the same specimen and the skull figured by Dr. C. Hart Merriam in his 'Monographic Revision of the Pocket Gophers' (North Am. Fauna, No. 8, p. 194, Pl. xv, Fig. 1, Jan., 1895), under the name *Macrogeomys cherriei* (Allen). Through the kindness of Señor Anastasio Alfaro, Director of the Costa Rica National Museum, I have before me five additional specimens, four of which are fully adult, and the other about half grown. The six specimens differ very little in coloration, all being dark sooty or plumbeous brown above and light, soiled grayish white below, slightly darker or more ashy gray over the pectoral region, the line of demarkation between the upper and lower surfaces being well defined. They all possess the prominent squarish or subtriangular white patch on the top of the head noted in the type, and thought possibly due to albinism. It proves, however, to be a normal and striking feature of the coloration. As regards external characters, there is nothing further to add to the original description, the skins being unfortunately not in condition to admit of satisfactory measurement. Señor Alfaro (in litt. May 31, 1895) says, however, that an adult male measures: head and body, 230 mm.; tail, 90; total length, 320. In the adults the length of the hind foot averages about 45 mm.

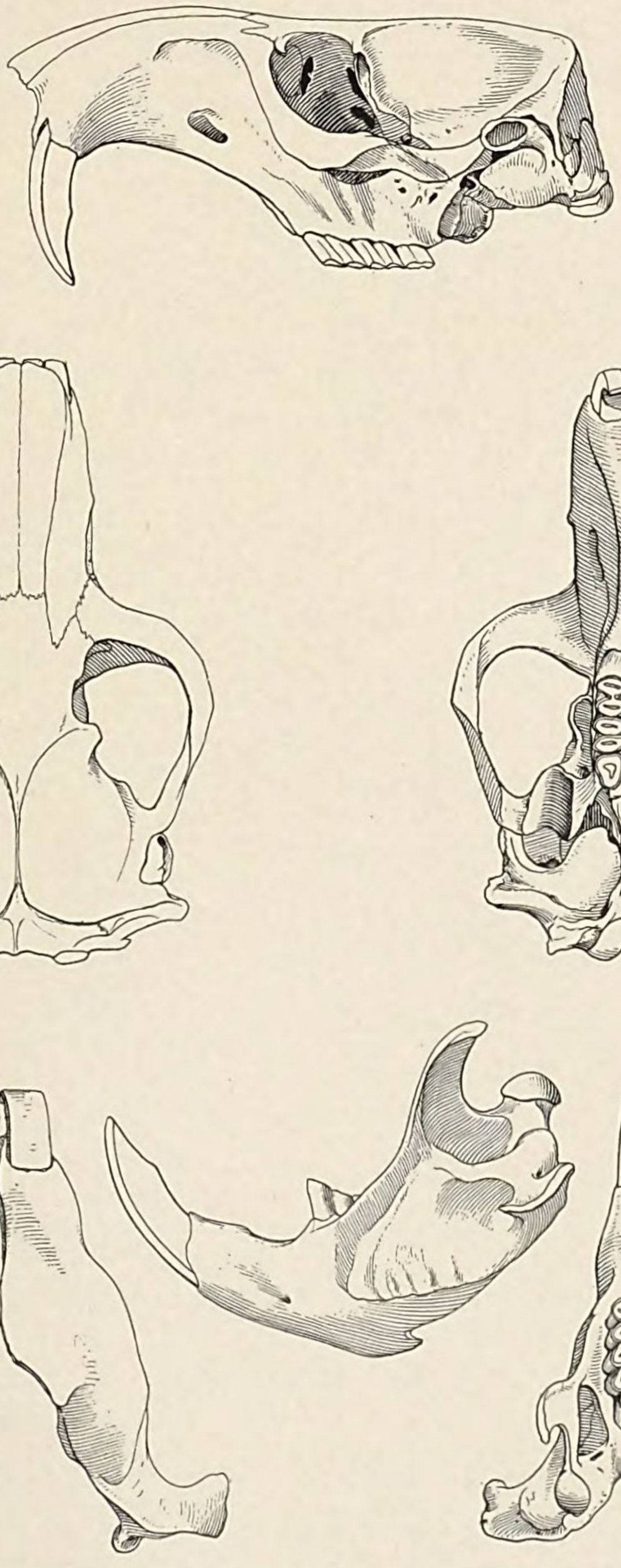
An adult male skull measures as follows: Total length (condyle to front base of incisors), 59 mm.; zygomatic breadth, 39; greatest breadth across squamosals, 33.5; interorbital breadth, 10; breadth of muzzle at root of zygoma, 13.5; length of mandible (without incisors), 14; greatest breadth of mandible at the

angular processes, 37.5 ; length of upper molar series (crown surface), 11. Ratio of zygomatic breadth to total length, 66.

From Señor Alfaro I learn that all of these specimens, including the type of the species, were taken on his father's plantation 'Santa Clara,' in the small town of Jiménez, on the Atlantic slope, at an altitude of only 700 feet above the sea. He also writes that *Geomys heterodus* Peters, which he describes as a very different animal from *M. cherriei*, is found only at an elevation of 6000 to 7000 feet. *M. cherriei* is very abundant about Jiménez, and very destructive to the coffee plantations. Seventy were taken in a single month on his father's estate.

The Museum is indebted to Señor Alfaro for several specimens of this interesting species, the type of which (Am. Mus. No. $\frac{10768}{9067}$) is also now the property of the Museum.

The accompanying figures (Pl. I) represent the skull of an adult male (Am. Mus. No. $\frac{10770}{9069}$), natural size. The specimen was taken at Jiménez, Costa Rica, in May, 1895, and forms one of the series referred to above.



Macrogeomys cherriei (*Allen*).

Figures all natural size.

## Article V.—ON MAMMALS COLLECTED IN BEXAR COUNTY AND VICINITY, TEXAS, BY MR. H. P. ATTWATER, WITH FIELD NOTES BY THE COLLECTOR.

By J. A. Allen.

The Museum has recently received from Mr. H. P. Attwater, of San Antonio, Texas, about 400 specimens of mammals, collected chiefly in the vicinity of San Antonio, in Bexar County, but including many from Kerr County. The specimens represent 37 species, on which Mr. Attwater contributes valuable field notes, and also important information on 10 other species found now or formerly in the vicinity of San Antonio. These are mainly the larger Carnivores and the larger game animals, as the Deer, Bison, etc., which are all now rapidly disappearing from the State. It hence becomes desirable to place on record the notes on their former status contributed by Mr. Attwater.

I am also indebted to Mr. Attwater for the following sketch of the topographic and other features of the region, and for interesting notes on the effect upon animal and plant life of the severe and long-continued droughts that periodically visit this portion of Texas.

Character of the Region.—Bexar County is on the line of junction of two regions of diverse topographic character, and is thus faunally a point of special interest, forming, as it does, about the eastern limit of various western forms, and the western limit of various eastern forms of animal and plant life. At about this point also various northern forms find their southern, and various southern forms their northern limit of distribution.[1] The following somewhat detailed account of the region is from Mr. Attwater's MS. notes.

"The city of San Antonio has an altitude of 680 feet above sea level, and is situated about 150 miles northwest of Rockport and

[1] *Cf.* Attwater, The Auk, Vol. IX, 1892, pp. 229, 230.

Corpus Christi, on the Gulf coast. For about 50 miles inland from these points the country is flat, but gradually becomes more rolling in Bee County, this character increasing till Bexar County is reached, where, directly north of San Antonio, the first elevation begins, and the country becomes rough and broken, the underlying rock being a soft cretaceous limestone. This elevation extends northward from San Antonio across the State, and also westward to the Rio Grande. The counties north and west of Bexar are much cut by erosion, which has formed terraced hills, covered with boulders, and deep valleys or cañons with steep rocky sides. In direct contrast with this rough region is the lower and more level country, beginning directly south of the city and extending to the mouth of the Rio Grande. The soil, south of this dividing line in Bexar County, is more or less sandy, with what is known as chocolate land (a mixture of reddish clay and sand) along the streams, while north of this line it is black, waxy, and mixed more or less with stones and gravel.

"The San Antonio River, a good sized stream, rises two miles north of the city, in some large springs which flow from the limestone. The Medina River, joined by the Leon, runs through the southern part of the county, and unites with the San Antonio River fifteen miles south of the city. Both the Medina and the Leon are dry most of the year, but water is always to be found in large pools and deep water-holes along their courses.

"The old settlers inform me that formerly the country around San Antonio, away from the streams, was open prairie, but now where it is not in cultivation it is covered with a thick growth of mezquit trees, and in some places with dense growths of thorny bushes and cactuses (*Opuntia*). The entire region north and south of San Antonio is well wooded, and next to the mezquit the prevailing growth on the upland is live oak, post oak and hackberry, with pecan, cottonwood, willow, elm, box-elder, sycamore, mulberry and cypress along the streams and creeks.

"Two miles south of the Medina River there is a long stretch of light sandy soil, extending into the adjoining counties, which is covered with a heavy growth of black oak and hickory. This particular locality is similar in character and supports the same growth of weeds as the sandy soil in Aransas County, on the coast.

"The mountain region north and west of San Antonio is mostly covered with spanish oak, shin oak and dwarf live oak, with much red cedar (*Juniperus*) scattered in places along the ridges and hillsides, often forming almost impenetrable 'brakes.'

"Many varieties of smaller trees, shrubs, vines, etc., grow throughout this region, along the creeks and ravines, and in the river bottoms, producing fruit, berries, etc., which provide an unlimited food supply for the wild animals. Good crops of the following are produced almost annually in a wild state: Wild grapes (several varieties), mulberries, dewberries, hackberries, barberries (*Berberis trifoliata*), cherries, plums, persimmons, acorns (many varieties), pecan nuts, walnuts, and hickory nuts. In addition to these and many other kinds of nuts and edible berries, there are numerous varieties of weeds which yield large quantities of seed, such as the wild sage (*Croton*) and sunflowers, and a host of other weeds, the seeds of which are eaten by rats, mice, pocket mice, kangaroo rats, etc.

"Most of the specimens sent were collected at odd times, during the last two years, and nearly all of them from two localities in this county, one of these places being around our house, three miles south of the city, and the other on Mr. John Watson's ranch, on the Medina River, about fifteen miles southwest of San Antonio, where I have made a number of trips to collect and hunt animals. I was particularly fortunate in having the assistance of Mr. Watson and his sons, who generally accompanied me, and who sent me many specimens, and furnished much valuable information.

"I also received much assistance from Mr. Gustave Toudouze, a good hunter and taxidermist, who also lives on the Medina River, and who had a fine collection of the large animals at the New Orleans Exposition in 1884. I have also had the advantage of being acquainted with Mr. David Menck, the proprietor of the Zoölogical Gardens in San Antonio, who owns a fine collection of live animals, and who has furnished me much useful information.

"Several trips were made to Kerr County, where some of the specimens sent were taken. They were caught at the ranch of my friend, Mr. Howard Lacey, on Turtle Creek. Mr. Lacey, besides having hunted deer and large animals for a number of

years, is a careful and reliable observer. I am indebted to him for many favors, and his note-book, which he placed at my disposal, afforded me much interesting and authentic information.

"EFFECT OF DROUGHTS ON ANIMALS.—Southwestern Texas is subject to periodical droughts, which render agricultural pursuits very uncertain, and, I am convinced, have a great influence on the lives of the animals here, especially the mice and rats which live above ground or have their nests and hiding places close to the surface.

"Several wet and rainy seasons are generally followed by several dry ones. In 1889, 1890 and 1891 there were good rains in the early part of the year, and fine crops were raised. In these years small animals of several kinds seemed very much more common than in 1892, 1893 and 1894, which were dry years—and especially 1894—during which period a severe drought prevailed all over this section of the State. In 1894 no small grains were raised, and the corn crop was almost a total failure in this county. We had fine rains in 1895, and a splendid crop of small grains and corn matured, and some small animals have of late become much more common, especially since the end of July, 1895. I have recently met with Harvest Mice and Sigmodons in localities where I know they were not to be found last year; and both these species have very recently been reported to me from other points as being noticed the first time for several years.

"In dry seasons the cattle eat off the weeds and grasses, leaving the ground bare, but with the heavy rains in the early part of 1895 the whole country became covered with a dense growth of vegetation, which afforded a hiding place to the small animals and protection from their enemies; besides providing them with an extra supply of food, and much more favorable conditions generally for their existence.

"These conditions do not affect the Pocket Gophers, Moles and Pocket Mice so much as they do the Mice, Rats, Rabbits, etc., whose homes and nests are mostly on or above the ground. When Rats, Mice and Rabbits are common, Skunks and other larger animals are noticeably more numerous."—H. P. A.

**1. Didelphis marsupialis virginiana** (*Kerr*). OPOSSUM.—Represented by 7 specimens, all from the Medina River bottoms, about 15 miles south of San Antonio. Two of the specimens have the dark coloration, wholly black feet, black basal portion of the tail, and dusky eye stripe characteristic of Rockport, Corpus Christi, and Brownsville specimens;[1] the others are quite like the ordinary northern (*virginiana*) style of this animal.

"Common, but generally met with along rivers and creeks. Black Opossums are occasionally met with, but not as often as at Rockport, on the coast. They eat all kinds of wild berries and fruits, and are especially fond of mustang grapes and persimmons. They also eat lizards and anything in the way of meat they can find. Mr. Lacey says that his dogs have often 'treed' them in the carcasses of dead cattle, and that they make the inside of a dead cow their temporary abode so long as there is anything left on the bones worth picking."—H. P. A.

**2. Didelphis marsupialis californica** (*Bennett*). TEXAS OPOSSUM.—Two specimens, as stated above—Medina River, Jan. 10 and Dec. 31.

**3. Tatusia novemcincta** (*Linn.*). NINE-BANDED ARMADILLO.—Although no specimens were sent, the following notes are entitled to record, as this animal is likely to be soon exterminated in the more settled parts of Texas.

"I have records of the capture of the Armadillo from many points north, south and west of San Antonio. Mr. Lacey reports it from Burnet County, 150 miles north of San Antonio, and one was killed this summer (1895) on his ranch in Kerr County. They are occasionally sent to the Zoölogical Garden alive, but do not live long in confinement."—H. P. A.

Mr. Attwater also sends newspaper clippings recording the capture of specimens in Kendall and Gillespie Counties, north of San Antonio, during 1894.

---

[1] *Cf.* this Bulletin, VI, 1894, p. 168.

**4. Dorcelaphus virginianus** (*Bodd.*). VIRGINIA DEER.—"Deer are still common in Bexar County, and are not as liable to be exterminated here as in other parts of the State, east and north of San Antonio. The immense pastures, enclosed with barbed wire fences, afford them great protection—the fences, sometimes miles in length, preventing hunting parties from leaving the public highways. The almost impenetrable stretches of chaparral thickets also afford them shelter, even when hunters' camps are located among them.

"Formerly, when the country was unsettled, and before the influx of market hunters, the deer, according to the old settlers, could be seen feeding in the daytime, but now they commence to feed about half an hour before sunset, and lie down soon after sunrise. They thus have apparently changed their habits as the country has become more settled."—H. P. A.

**5. Dorcelaphus hemionus** (*Raf.*). MULE DEER; BLACK-TAILED DEER.—"The extreme eastern limit of the range of the Black-tailed Deer is west of Edwards County. I have heard of their being killed in Val Verde County, but they are rare east of the Pecos River."—H. P. A.

**6. Antilocapra americana** *Ord.* ANTELOPE.—"Formerly the Antelope ranged eastward in Texas to within 100 miles of San Antonio and southward along the Rio Grande, but they are not now found so far south in this State. According to Dr. J. B. Taylor—to whom I am indebted for valuable information about the range of this Antelope—there are still about 100 on his ranch in the northwest corner of Sutton County, which he thinks is now about the southeastern limit of their range. A few scattered bunches may still be found eastward to Menard County. A straight line running west from Sutton County, Dr. Taylor thinks, will mark their present southern limit. Another line drawn from Sutton County slightly west of north to Amarillo in Potter County will, he believes, mark their present eastern limit in Texas, although a few may straggle further east."—H. P. A.

**7. Bison bison** (*Linn.*). American Bison.—In May and June, 1894, reports[1] came from San Antonio, Texas, of the discovery of a herd of about 40 to 50 wild 'Buffalo' in Val Verde County, Texas, which were so circumstantial as to lead many to believe in the reputed discovery. Later[2] the number had increased to 60, and the herd had left the fertile valleys of Val Verde County and, passing into the valley of the Rio Grande, followed up that stream till they found a convenient crossing place and passed over into Mexico. An expedition which had been organized, with headquarters at San Antonio, for the purpose of 'rounding up' the herd and bringing it into captivity, was therefore indefinitely postponed. Apropos of the foregoing, the subjoined notes from Mr. Attwater, a resident of San Antonio, and an enterprising naturalist as well, become of special interest.

"A year or so ago a herd of Wild Buffalo was reported seen in Val Verde County, 150 miles west of San Antonio, between Devil's River and the Rio Grande. Since then a number of hunters have searched for them, but so far as I know no sign of them has been seen. Many people do not believe the report. If it was correct, it is strange that they have not turned up somewhere since, or at least been heard from in some way.

"Reliable persons tell me that 1886 was the last year for Wild Buffalos in western Texas, and I think it is safe to say there are none in Texas to-day in a wild state. There are several herds in captivity on large ranches in northwestern Texas.

"I send a dorsal vertebra and rib from a mounted Buffalo now in my collection. It was caught when a little calf in a wild state in 1883, in Borden County, at the head of the Colorado River. It was raised by a common cow, and castrated when two years old. It grew to a large size, and was exhibited at the State Fair two years ago. It weighed 3506 lbs., stood 6 feet 4 inches high, and was 10 feet long. It died in 1893, and then came into my possession."—H. P. A.

Later Mr. Attwater wrote me, on the authority of Dr. J. B. Taylor, one of the most prominent stockmen in western Texas,

[1] 'Buffalo in Texas' (signed 'O. C. G.'). Forest and Stream, XLII, p. 421, May 19, 1894; and *ibid.*, p. 510, June 16, 1894.

[2] 'The Texas Buffalo Herd.' *Ibid.*, XLIII, p. 377, Nov. 3, 1894. From the 'San Antonio Express' of Oct. 6, 1894.

and whose headquarters are in San Antonio, that "the Val Verde Buffalo herd was only a myth." The report appears to have been originally started as a 'joke,' but for a time seems to have been believed in by some of those who were prominent in giving it currency.

**8. Dycotyles angulatus** *Cope.* TEXAS PECCARY.—No specimens were sent, but Mr. Attwater reports a mounted example in his collection, and contributes the following notes.

"Not often met with now near San Antonio, but still common in the chaparral region south and west of San Antonio. Mr. Lacey reports that they were formerly common in Kerr County, but are seldom seen there now.

"Ten years ago there was a great trade in skins and hides of wild animals in San Antonio, and the prices paid by dealers were much higher than now. Hides of the 'Havelina,' as the Peccaries are called here, were in demand, and wagon loads of them could be seen at the depots and commission warehouses. I am informed by Messrs. Cohen & Co. that their firm handled over 30,000 'Havelina' hides in one season, eight years ago. The highest price paid then was 80 cents for a No. 1 hide. They were shipped east, and most of them went to Europe, the skins being used for gloves and the hair for brushes. The price paid now is about 30 cents, with few coming in, and last season's stock still on hand. A ranchman in Zavalla County told me that in 1886 'Havelina' hides were currency in that part of the State. At a store at Luma Vista, in the same county, a small skin would be returned over the counter with a certain quantity of tobacco, etc., in exchange for a large skin.

"They thrive in captivity. A pair in the Zoölogical Garden have bred there for the last six years, bringing their young at any season of the year, and having from one to three at a time.

"The nature of the Peccary seems to have toned down considerably from its old-time ferocity. Formerly, it is said, they knew no fear, but the few herds I have met with showed a very different disposition, being intent only on flight. Probably, however, where they have not been relentlessly persecuted by hunters they still retain their former spirit and bravery."—H. P. A.

## 9. Lepus merriami *Mearns.* Rio Grande Jackrabbit.

*Lepus callotis* Baird, Mam. N. Am. 1857, p. 590 (nec Wagler; Texas references only).
*Lepus callotis*, var. *callotis* Allen, Mon. N. Am. Roden. 1877, p. 350 (Texas references only).
*Lepus callotis* Allen, Bull. Am. Mus. Nat. Hist. VI, 1894, p. 169. (Rockport and Corpus Christi, Texas.)
*Lepus melanotis* Allen, *ibid.* p. 348 (the Rockport, Texas, specimens only).
*Lepus merriami* Mearns, Proc. U. S. Nat. Mus. XVIII, 1896, No. 1075, p. — (page 2 of 'advance' sheet, issued March 25, 1896).

All of the 15 (11 adult and 4 young) Jackrabbits from the vicinity of San Antonio are referable to *Lepus merriami*, recently described by Dr. Mearns (l. c.), as are also the specimens recorded by me from Rockport and Corpus Christi, Texas, provisionally under the name *Lepus callotis*, and later referred in part to *L. melanotis*. Several of the specimens, however, are wholly without black on the nape, and have little or no black at the base of the ears; other examples show more or less black on these parts, grading into those with a large black nape patch and a broad area of black at the base of the ears. This variation is hard to explain, as it is apparently not due to age, sex, or season. The gray-naped specimens prove, on comparison, easily separable by general features of coloration from *L. melanotis*, aside from the presence of good cranial differences.

The collector's measurements of these specimens are as follows, total length and length of tail being taken *to the end of the tail hairs* instead of to the end of the caudal vertebræ. The hairs extend about 25 to 30 mm. beyond the tail vertebræ.

| Cat. No. | Sex. | Date. | Length. | Tail. | Hind foot. | Weight. |
|---|---|---|---|---|---|---|
| 11861 | ♀ ad. | Nov. 22. | 620 | 108 | 127 | 5 lbs. 12 oz. |
| 11860 | ♀ ad. | " 29. | 626 | 102 | 133 | 5 " 14 " |
| 10314 | ♀ ad. | Feb. 13. | 615 | 104 | 131 | 5 " 12 " |
| 10315 | ♀ ad. | " 15. | 558 | 95 | 131 | 4 " 0 " |
| 10317 | ♀ ad. | April 17. | 604 | 114 | 133 | 7 " 0 " |
| 10316 | ♂ ad. | June 19. | 622 | 127 | 131 | — — |
| 11859 | ♂ ad. | Jan. 10. | 620 | 109 | 130 | 5 lbs. 12 oz. |
| 11862 | ♀ ad. | Nov. 8. | — | — | 133 | 6 " 6 " |
| 11857 | ♀ ad. | " 20. | 648 | 127 | 133 | 7 " 0 " |
| 11858 | ♀ ad. | Dec. 5. | 622 | 108 | 133 | 7 " 0 " |
| 11863 | ♀ ad. | " 28. | 610 | 102 | 131 | 7 " 0 " |

One of the young ones (March 4) is about one-fourth grown ; the other three (Jan. 10, April 12, and July 6) are very young, apparently nurslings. A young Rockport specimen, taken Oct. 11, is only a few days old. A female taken Dec. 8 is labeled as containing one small embryo, and another taken Dec. 28, contained one large embryo. It is thus evident that the young are born at irregular intervals nearly throughout the year.

Mr. Attwater says Jackrabbits are "common everywhere, but less numerous in the broken country north of San Antonio than in the mesquit lands between San Antonio and the Gulf Coast." In winter they feed on the "tips of the mesquit and other thorny shrubs, and even on the leaves of the prickly pear cactus (*Opuntia*)." In winter he has measured their tracks in the snow showing leaps of 15 feet, and thinks "they would do even better than this when pursued by a hungry Coyote."

**10. Lepus sylvaticus bachmani** (*Waterh.*). Texas Wood Hare.—Represented by 16 specimens, 13 of which are adult; the three young vary in age from 10 to 45 days, according to Mr. Attwater's memoranda on the labels. The series is not distinguishable from Rockport and Corpus Christi specimens. The collector's measurements of 10 adults (5 ♂♂ and 5 ♀♀) are as follows : Total length (to end of tail hairs), 409 (380–425) ; tail (to end of hairs), 55 (45–64) ; hind foot, 90.6 (85–95).

"Common everywhere, but much more numerous in the chaparral region south of Bexar County, than to the north of it. Two of the young ones are from a nest in our garden. The nest was discovered on July 19—a shallow hole in the ground under a tomato vine, six feet from the kitchen window. It was composed of strips of cedar bark and lined with rabbit fur. It contained three young ones apparently a day or two old. On July 25 their eyes were open. On July 27 one was taken from the nest and preserved as a specimen (No. 134). July 29 the two little ones that remained left the nest, being then about two weeks old. One of them was caught two days later in a steel trap set near the nest. During all this time the old rabbit was not seen. The only time she could have visited the nest was during the middle of the night. The garden was surrounded with what was sup-

posed to be a rabbit-proof fence. I never found where she went in and out. It was a very dry season, and vegetation was everywhere dried up except in this small garden. She evidently selected this so that the little ones would find something to eat. The whole affair was nicely arranged and very well managed for a rabbit."—H. P. A.

**11. Geomys texensis** *Merriam.* TEXAS GOPHER.—Represented by 11 specimens, 7 males and 4 females, collected about 15 miles south of San Antonio. Six adults measure as follows: Total length, 223 (203–237); tail vertebræ, 72 (60–79); hind foot, 27 (25.4–29). These measurements are slightly above those given by Dr. Merriam for his series from Mason County.

Mr. Attwater sends the following interesting notes on the range of Pocket Gophers in Bexar and adjoining counties:

"Pocket Gophers are found only in the sandy parts of the country. They are very common in the extreme southern and southwestern part of this [Bexar] county, their northern limit here being about eight miles south of San Antonio. From San Antonio northward for about 100 miles, or through Bexar, Bandera, Kendall and Kerr Counties, I have never found them. There may be some isolated colonies, if sandy tracts occur in the region embraced in these counties. Further north they will probably be first met with in Gillespie County, just north of the Perdenales River, for I have heard of gopher mounds being seen there. There is, therefore, apparently an area of nearly 100 miles in north and south extent where no Pocket Gophers exist."—H. P. A.

**12. Perodipus ordii** (*Woodh.*). ORD'S KANGAROO RAT.—Represented by 5 specimens, 1 male and 4 females, taken 18 miles south of San Antonio, Aug. 23–Sept. 18. A female taken August 23 contained "two small embryos."

"These beautiful little animals appear to be quite common in the sandy black oak region south of the Medina River in Bexar County. Their burrows seem to be most numerous in the poorest, sandy soil."—H. P. A.

**13. Perognathus paradoxus spilotus** *Merriam.* TEXAS POCKET MOUSE.—A series of 42 specimens, of which all but 8 are adult, seem practically indistinguishable from Rockport examples.

"Much more numerous in the sandy lands than in the black lands; prefer wild land to cultivated fields. Similar in habits to those found about Rockport [see this Bulletin, VI, 1894, pp. 173, 174]. They undoubtedly carry the dirt out of their burrows in their cheek pouches. When kept alive in confinement they become very tame and seem to like to be handled."—H. P. A.

Two were sent alive by Mr. Attwater in May, 1895, to the Museum. One of them died in transit, after reaching New York; the other lived contentedly for weeks, in an open box covered with wire netting, but finally escaped. Mr. Attwater had had them two months before shipping them, during which time they fed readily on cane seed, oats and corn, but had received no water.

**14. Perognathus flavus** *Baird.* YELLOW POCKET MOUSE.—Represented by 26 specimens, 22 of which are fully adult, one is nearly adult, one is about half grown, and two are nurslings.

Two are from Kerr County, and the rest from the immediate vicinity of San Antonio. They were taken mainly between Feb. 25 and May 18, and Sept. 15 and Nov. 20. The two nursing young were taken May 18.

The nurslings are dusky gray above and pure white beneath, with a very narrow sharply defined deep fulvous lateral line, pale fulvous eye-rings and postauricular patches. A half-grown specimen is quite similar in coloration.

Two adults were received alive from Mr. Attwater, one of which is still living at the Museum, apparently in good health after being in captivity for ten months. He is furnished at frequent intervals with little quantities of bird seed, a part of which he eats at once and the remainder he carries into his burrow, working industriously till all is hidden away. Formerly he was given water, bread and a greater variety of food, but the mixed bird seed seems to supply all his needs. As he showed no desire for water, he has been offered none for the last eight months. He is quite tame, has a sleek well-kept coat, and appears to consider his lonely life well worth living.

"Very common, and, like the larger species (*paradoxus*), prefers the sandy land to the black soils, but, unlike *paradoxus*, prefers cultivated lands, and particularly old fields. They are often turned up by the plow in spring, and occasionally hoed up in summer. When turned out and kept alive a cold night will put them to sleep, so that they appear dead in the morning ; but they soon recover animation when warmed up and resume eating. I have kept them alive for several months, feeding them with corn, oats, bran, etc. One lived for several months in a cage with a large *P. paradoxus*."—H. P. A.

**15. Mus decumanus** *Pall.* Brown Rat.—One specimen, ♂ ad., San Antonio, Jan. 27, 1894. Total length, 413; tail vertebræ, 209; hind foot, 51.

"Common in the city of San Antonio, but not as yet met with on the ranches."—H. P. A.

**16. Mus musculus** *Linn.* House Mouse.—Represented by 13 specimens, which present a wide range of variation in color. One (No. 10410), not fully adult, is of the clear gray color common to half-grown specimens of *Peromyscus* of the *leucopus* group. Another (No. 10412) is the reddest House Mouse I have ever seen from any locality, not excepting the red desert regions of Arizona. The color above is strongly reddish fawn, much varied with black, while the lower surface is reddish buff. Several others are nearly as red, while one or two depart little from the usual color of the House Mouse.

"The common House Mice are here often found away from houses and buildings, living in holes in the ground and in hollow trees.

"Inside a house, the organ is a place frequently selected by mice in which to make their nests, and they do not seem to mind the noise made by playing on the instrument. I believe that mice have ruined organs in thousands of houses in the United States, and that often when an organ gets 'out of fix,' and the trouble is not exactly known, that the cause may be found inside the case, curled up in a snug nest, a part of which has been gnawed from different parts of the interior of the instrument."—H. P. A.

**17. Neotoma micropus** *Baird.* TEXAS WOOD RAT.—Represented by 23 specimens, of which 18 are adult and 5 young, taken in the vicinity of San Antonio, in January, February, July, August, October and November. They are not appreciably different from Rockport and Brownsville (Texas) specimens, and Mr. Attwater says they have the same habits.

"Common all over this region. The habits of the San Antonio Wood Rats are the same as those of the Wood Rats at Rockport. When caught in traps by the feet they immediately begin to eat off the limb that is held, and frequently escape in this way. No. 95 [Am. Mus. No. 10365] has both feet missing; the stumps were nearly healed when it was caught the second time in a steel trap. Mr. Watson says he has found a half a bushel of pecan nuts in a Wood Rat's nest. Their nest piles are seldom found on the river bottom lands, but some are met with on the higher pecan lands near the river. Their favorite resorts, however, are the high dry chaparral region.

"These Wood Rats have a habit of stamping with their hind feet when annoyed or disturbed. On several occasions when setting traps for them at their holes I have heard the rats stamping inside. Also on one occasion I saw a rat thus stamping in our greenhouse while sitting in a corner."—H. P. A.

**18. Neotoma mexicana** *Baird.* MEXICAN WOOD RAT.—Represented by 8 specimens—5 adults and 3 immature—taken on Turtle Creek, Kerr Co., March 12 and Dec. 10–14, 1895. This locality is doubtless on the eastern border of the range of this species, which here meets that of *M. micropus.* The latter is common about San Antonio, where *N. mexicana* has not been met with.

Most of the specimens were dug out from their holes, Mr. Attwater having found it difficult to trap them during his short excursion to the head of Kerr Creek, in Kerr County, where they were obtained, owing to their gnawing off their feet when caught, or being destroyed by predacious animals. He says:

"One of the rats was found under a pile of brush, on damp ground in a creek bottom, and was easily caught. The other

five [of the series taken in December] were found on high land—one on an oak ridge and four in a cedar brake—and had to be dug out of their retreats, from two to three feet below the surface, among rocks, at the end of passages six to ten feet long, leading gradually down from their nests.

"All the nests were in heaps of rubbish piled up by the rats; those in the cedar brake were heaped around cedar trees, and the nests were made in the hollows among the roots of the trees. These nests were composed of fine strips of cedar bark; the nest in the creek bottom was made of grasses, leaves, and also cedar bark. Only one rat was discovered in each nest, but several nests were found in some of the heaps. The 'rat heaps,' or mounds of material which the rats pile up over their nests and retreats, average two feet high, and are composed of any kind of rubbish that comes handy, chiefly sticks, stones, and dry horse and cow manure. Like *N. micropus*, they also go into houses and barns on the ranches and build their homes. A favorite place is the corner of some old shed or 'tumble-down' shanty. One we found on Mr. Lacey's ranch was constructed chiefly of stones and old pieces of board, with sticks and other rubbish, including shingles that had fallen from the roof. Some of the stones and pieces of lumber on the pile were quite heavy, and it seemed almost incredible that a rat could have carried them on to the pile. One of the heaviest things, on the top of this particular pile, was a piece of board, 14 inches by 10 inches, and weighing 2½ lbs. These rats, if permitted, will make their abodes under houses occupied by people, and, in the absence of cats and dogs, enter the house and become quite friendly, helping themselves to small articles to add to their pile. In one instance a tobacco pipe was one of the articles taken.

"We found in some of the heaps large quantities of small green cedar boughs. These boughs are cut off the trees by Fox Squirrels, for the purpose of obtaining the cedar berries, which are more easily taken from the branches after they have fallen to the ground. In one of the underground passages at the nest on the oak ridge were found, stored away, about three dozen bunches of wild grapes; also many acorns and black haws. In another nest in the cedar brake were about two dozen small mushrooms,

partly dry and shrivelled. All the heaps in the cedar brakes contained large stores of cedar berries, most of them with the outside pulp eaten off, and the seeds eaten out. When the very small size of the seed is taken into consideration, it is surprising what an immense amount of work is necessary before enough can be obtained for a meal, as probably a thousand would be required. One nest contained shells of nuts of the Mexican buckeye (*Ungnadia speciosa*), although these nuts are reputed to be poisonous.

"The range of this rat in this part of Texas will probably be found to coincide with that of *Peromyscus attwateri*."—H. P. A.

**19. Sigmodon hispidus texianus** (*Aud. & Bach.*). Texas Cotton Rat.—Represented by 22 specimens, taken mostly between September and February, and all at San Antonio except 2, which were taken at Mr. Lacey's ranch in Kerr County. The San Antonio specimens have a decidedly grayer cast than those from the coast region of Texas.

Mr. Attwater's notes, here following, show that these rats are subject to great variation in respect to abundance at the same locality in different years.

"After the great 'Tramp Rat' raid in 1889, referred to below, these rats gradually disappeared and for several years I lost sight of them entirely, and did not hear of any around San Antonio or in any other parts of Bexar County. It again came to my notice on Feb. 9, 1895, when a young one was taken on Mr. Lacey's ranch, in Kerr County. It was next again noticed at San Antonio on August 17, 1895, when one was taken in a cactus patch not far from my house. This particular patch had been well trapped for Wood Rats for some time previously, and the Sigmodons must have come in from elsewhere. All the specimens now sent, [quite a large series,] were taken in this same patch, which is on high, dry land. They have also become common again in Kerr County. In a recent letter from Mr. Lacey (dated Jan. 26, 1896), he says: 'The garden is full of 'Tramps.''

"In the year 1889, Sigmodons appeared suddenly in this [Bexar] county in great numbers, and were known as 'Tramp Rats.' Where they came from, or from which direction, I have

been unable to find out. Thousands first appeared about the 1st of May, and were heard from in all the region for many miles round San Antonio. They were most numerous in the high, dry parts of the country, and were not noticed in the low lands along the rivers. They were very numerous all through the 'chaparral,' and made their nests with the Wood Rats (*Neotoma*) in the bunches of *Opuntia*, with a network of runways leading in every direction, through which they were often seen running in the daytime. They seemed to agree with the Wood Rats, but in the oat stacks and around the ranch buildings, the common Brown Rats fought, killed and ate them. Mr. Watson's boys killed over 100 in one afternoon in a brush fence, and for *several months* their cat used to bring in from 6 to 12 every night. He says that on one occasion, when the rats were thickest, they counted 38 which this cat had piled up in the wood-box during one night for the amusement of her kittens.

"The 'Tramp Rats' played particular havoc with all kinds of grain crops, and corn in particular, but they were not good climbers, and consequently the ears on leaning stalks suffered most. Some farmers lost half their corn crop, and in some instances small patches were entirely destroyed.

"During the winter of 1889 and 1890 Marsh Hawks were very numerous, no doubt attracted by the rats. The hawks were seen skimming over the fields in the daytime chasing the 'Tramps.' In 1890 and 1891 Short-eared Owls, on their way north in the month of March, stopped over to attend to the Sigmodons; in other years I have not noticed these owls during migration. Weasels and Little Striped Skunks were much more common than usual in 1890 and 1891, which I attribute to the same cause. Rattlesnakes and other snakes were seldom seen abroad, and when disturbed in their retreats, were found gorged with Cotton Rats. The large skunks and coyotes hunted them, and dogs, generally in the habit of killing rats and mice, and *shaking* them only, also ate them.

"The bulk of these rats stayed for about eighteen months. After the crops were gathered in 1890, they began to get scarce, and gradually disappeared during 1891. Whether they died out, or 'tramped' out, I am unable to say, but I am inclined to think

many of them migrated. Old settlers say they remember a similar invasion about the year 1854.

"No. 29 [=No. 10413, Am. Mus.] is one of the San Antonio 'Tramp' Rats taken Dec. 20, 1890. It appears similar to the Rockport specimens; perhaps a little lighter in color. I also sent several skins and nests at that time to Dr. C. H. Merriam, of the U. S. Department of Agriculture.

"Their nests, made of grass, and easily noticed, were placed on the ground in the middle of clumps of brush and bushes and at the roots of trees. Old stumps, hollow logs, and among weeds, along banks and fence-rows, were also favorite places. When disturbed they retreated into shallow holes in the ground, under the nests, and in these holes other nests were found. The rats were easily got at by digging, and from one to six usually found in a hole."—H. P. A.

**20. Peromyscus texanus** (*Woodhouse*). TEXAS WHITE-FOOTED MOUSE.—Mr. Attwater's collection contains 11 specimens of a small, short-tailed *Peromyscus*, which Dr. Mearns has kindly examined and identified as above. Seven of the specimens are adult and four are more or less immature.

"These were caught in traps set for Harvest Mice, around the same brush piles. I think they live in shallow holes under the brush piles."—H. P. A.

**21. Peromyscus canus** *Mearns.*

*Peromyscus canus* MEARNS, Proc. U. S. Nat. Mus. XVIII, 1896, No. 1075, p. — (p. 3 of 'advance sheet,' issued March 25, 1896).

Represented by 30 specimens, collected chiefly in March, April and July, but a few were taken from October to February. About one-half are adult and the rest more or less immature. They differ chiefly in external features from large series of *P. mearnsii* from Rockport and Brownsville in having shorter and more hairy tails and rather smaller ears. Most of the specimens were taken in the vicinity of San Antonio, but three were collected on Turtle Creek, Kerr County, 75 miles northwest of San Antonio, where, however, the species, according to Mr. Attwater, is apparently not common.

"The White-footed Mice around San Antonio live mostly in holes in trees, and along the rivers in holes, caves, and crevices in the high banks and bluffs. Their nests are sometimes found in beehives, and frequently in old birds' nests, those of the Cactus Wren and Yellow-headed Verdin being often selected, on account of their convenient shape. The mouse makes its nest usually of grasses, weed-stalks, and other soft material. The nest sent to you was found March 29, 1894, in a hole on the bank of the Medina River, and is made of white cotton rags chewed up. The favorite food of this species here is pecan nuts, acorns, corn, various kinds of grain and weed seeds. They store up pecan nuts in hollow logs and piles of cordwood in the river bottoms."
—H. P. A.

**22. Peromyscus attwateri** ALLEN. ATTWATER'S CLIFF MOUSE.

*Peromyscus attwateri* ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 330. (Published Nov. 8, 1895.)

In addition to the 14 specimens of this species already recorded (l. c.), 4 have been received since, taken by Mr. Lacey at his ranch in Kerr County, Nov. 15, 1895, and Jan. 7, 1896. Three are adult and the other about half grown. All are males. One of the adults has a small pectoral spot of bright fulvous, making two thus marked in a series of 18 specimens. Mr. Attwater states that Mr. Lacey captured one that was "solid bright chestnut all over the upper parts, and had a very plain breast spot," but that unfortunately it was destroyed by a cat.

**23. Peromyscus (Baiomys) taylori** (*Thomas*). TAYLOR'S MOUSE.—Represented by 10 specimens, of which only 5 are adult, taken at Watson's Ranch, 15 miles south of San Antonio, March 23, May 9 and 29, and Dec. 28. Also two nests. The adults are quite different from fall adults (Aug. 23–Oct. 15) from Brownsville, the pelage being longer and fuller and more varied with brown; but the difference is doubtless seasonal, as the Brownsville specimens are in the new and only partly-grown fall coat, the pelage being thinner and shorter and more plumbeous.

"The specimens sent were taken under a pile of dry weeds and rubbish in an orchard, where the two nests sent were also found. There were several others with them, which escaped. The two specimens taken in March were kept alive till May 29. They were fed on sugar cane seed, oats, corn and bran. They used to drink water when I put it in the cage, but appeared to do just as well without it. The live one I sent you[1] never got any water.

"One of the nests sent was found by Mr. Watson while digging up a small pecan tree in the river bottom near his ranch. The nest was about a foot below the surface of the ground among the roots of the tree, and several passages led down into the ground, below the nest. In one of these holes a number of pecan nuts were found. The nest contained an old female and three half-grown young.

"This mouse evidently is likely to be met with in any locality, as I have found it in all kinds of country. It is not numerous, nor easily found, but one occasionally gets into traps which are set for *Perognathus*, *Peromyscus*, and *Reithrodontomys*. It is apparently evenly distributed, and not restricted, like some other small mammals, to certain kinds of places."—H. P. A.

**24. Reithrodontomys mexicanus intermedius** *Allen.* Rio Grande Harvest Mouse.—Represented by 9 specimens, 6 of which were taken at or near San Antonio (May, August, January, February and March), and 3 at Turtle Creek, Kerr Co., (January and February). They do not differ appreciably from a September series from Brownsville, Texas, except that all but three (August specimens) are in softer, longer and much fuller pelage. Two of the August specimens differ from the rest of the series in rather more rufous coloration. One of these, a female, bears on the label: "Found, with three young, in a nest in a peach tree in Watson's orchard, August 23, 1895."

"I am inclined to think the Harvest Mice are not as common as they used to be, and Mr. Watson is of the same opinion. I used to come across them occasionally in 1889 and 1890 while hunting for birds' nests on the Medina River. They were

[1] This specimen was received in good condition, and lived in confinement for about two months, when it died. It subsisted chiefly on bird seed, which it preferred to bread. Water was placed in its cage at intervals, but it was not seen to drink.

found singly, in the daytime, in little round nests, made of fine grass, placed in the lower branches of small trees."—H. P. A.

**25. Reithrodontomys dychei** *Allen.* DYCHE'S HARVEST MOUSE.—Represented by 28 specimens, mostly more or less immature, taken at San Antonio, Dec. 13, 1895, to Jan. 23, 1896, except one, taken at the same locality Sept. 21, 1895. This species I have previously recorded (this Bull., VII, 1895, p. 236) from Mason, Mason Co., Texas. The present locality is within the range of *R. mexicanus intermedius*, both species occurring together in the same field at San Antonio, showing that their ranges overlap.

**26. Sciuropterus volans** (*Linn.*). FLYING SQUIRREL.—Mr. Attwater reports a single specimen taken on the Guadalupe River, 40 miles east of San Antonio.

**27. Sciurus niger limitis** (*Baird*). PECOS FOX SQUIRREL.—Watson's Ranch, Medina River, 15 miles south of San Antonio, Dec. 4, Jan. 10, June 22—8 specimens; Turtle Creek, Kerr County, May 23—1 specimen. The collector's measurements of 4 of the specimens (2 ♂♂, 2 ♀♀) as recorded on the labels are as follows: Total length (to end of tail hairs), 532 (483–555); tail to end of hairs, 280 (254–305); hind foot, 64.5 (63.5–66). They vary considerably in color, especially below, one (an old nursing female) having the whole ventral surface pale buffy white, and the outer edges of the tail bordered with the same tint; another is nearly pure white below; six others vary from pale buff below to deep orange. One is apparently albinistic, being brownish yellow above washed with gray, but of the usual orange buff below.

"Common everywhere in this region. Many of them are white beneath, and are said to be the younger animal, but I have taken young squirrels that were *not* white below."—H. P. A.

**28. Spermophilus grammurus buckleyi** (*Slack*). BLACK ROCK SQUIRREL.—Four specimens, Turtle Creek, Kerr County, Aug. 20, Nov. 15 and Dec. 4.

These specimens agree with Dr. Slack's description of his *Spermophilus buckleyi* (Proc. Acad. Nat. Sci. Phila., 1861, p. 314),

based on a distorted, flat furrier's skin from Pack-saddle Mountain, Llano Co., Texas, except that the area of black is rather larger and extends further back in two of the specimens, being continued in a broad band on to the base of the tail. The black is pure glossy black, as in Baird's *Spermophilus couchi*, described from two specimens from respectively Santa Catarina, Nuevo Leon, and Victoria, Tamaulipas (Proc. Acad. Nat. Sci. Phila., 1855, p. 332, and Mam. N. Am., 1857, p. 311), which were "entirely of a glossy black." In the Turtle Creek specimens the black merges into the gray of the sides, occupying nearly the whole of the dorsal aspect as far back as the middle of the back, where it gradually becomes restricted to the middle of the dorsal area, leaving the posterior third of the body mostly gray. Here, and on the ventral surface, however, the black basal portion of the pelage more nearly approaches the surface than in normal specimens of *grammurus*, imparting to these parts a darker general effect.

In general appearance this semi-black form of Rock Spermophile strongly suggests a melanism of *S. grammurus*, but its local and yet somewhat extended distribution in southwestern Texas seems to imply that it is not strictly comparable to the black phases so often met with in various species of *Sciurus*, it having a distinct geographic range where it occurs to the exclusion of the ordinary phase of *grammurus*. It is, however, quite variable in respect to the extent of the black area and the manner of its distribution, even in individuals taken at the same time and place. Apparently also the amount of black increases from the northern part of its range southward, becoming wholly black in *S. grammurus couchi* in the region south of the Rio Grande.

Respecting its distribution and habits in the region northwest of San Antonio, Mr. Attwater contributes the following:

"These Black Rock Squirrels are found in the cañons and ravines around the heads of the Medina and Guadalupe Rivers. The nearest point to San Antonio where I have heard of their being seen is on San Geronimo Creek, at Gallagher's Ranch, 25 miles northwest of San Antonio, where a single one was seen several years ago by Mr. Frank Edwards, an enthusiastic hunter and

close observer. This must have been a straggler, as I should not expect to find their regular range nearer than 60 miles northwest of San Antonio, near the northern border of Bandera County, nor to find them common till well into Kerr County. There is a colony at the head of Johnson Creek, a fork of the Guadalupe River, about 20 miles north of Kerrville. On May 9, 1895, I visited this locality with Mr. Lacey to procure specimens. We watched the cliff, where the squirrels live, for more than an hour from the opposite side of the cañon, during which time a dozen or more, of various ages, came out of the holes and crevices in the rocks. We peppered them with small bullets and coarse shot. Two or three were killed outright, and others were wounded, but we were obliged to leave them on the inaccessible ledges, and reluctantly returned without securing a single specimen. Some of the largest appeared very black, but some of the smaller ones were of a grayish color all over. The four specimens sent you are from the head of Turtle Creek in Kerr County, and were kindly obtained and prepared for me by Mr. Lacey.

"These Rock Squirrels are not generally distributed over the country, like the Tree Squirrels, but live in colonies, a dozen or more miles apart, and generally in some favorite cliff or cañon near the heads of the creeks that form the sources of the rivers. When occurring near ranches these squirrels do considerable damage to the gardens and cornfields. They are expert climbers, making their way up the perpendicular faces of cliffs with ease. Unless disturbed or alarmed their progress is slow and their movements are more like those of a creeping reptile than the lively skip of a squirrel. If they bounded swiftly from rock to rock there would be nothing to excite surprise, but when seen slowly crawling along the underside of an overhanging ledge of apparently smooth limestone one's curiosity is excited, and you watch their movements with surprise. On being alarmed, however, they move with great quickness.

"This is the only Spermophile I have met with near San Antonio, Bexar County being apparently outside of the range of either *Spermophilus mexicanus* or *S. tridecemlineatus*. The former may occur not far from the southwestern border of this county, or on

the other side of the Medina River, 25 miles south of San Antonio, where *Perodipus* is found."—H. P. A.

**29. Cynomys ludovicianus** (*Ord*). PRAIRIE DOG.—"Bexar County is outside of the Prairie Dog region, but I saw one in a wild state on a ranch about twenty miles west of San Antonio in 1889. It made its burrow near the ranch, and was finally killed by hunters."—H. P. A.

**30. Castor canadensis** *Kuhl.* BEAVER.—Mr. Attwater reports the Beaver as formerly found northwest of San Antonio, and states, on the authority of Mr. Lacey, that it is still found sparingly on the Little Llano and Perdinales Rivers. Mr. Attwater also sends a newspaper record of the capture of a specimen by a trapper near San Angelo, about April 10, 1895, weighing 82 pounds.

**31. Nyctinomus brasiliensis** *Is. Geoffr.* HOUSE BAT.—Represented by a series of 15 specimens, two of which are from Kerr County, and the rest from the immediate vicinity of San Antonio. Mr. Attwater says this is the most common of the Bats, and that it lives in holes and crevices in the roofs and walls of houses. He also contributes the following interesting note on Bat caves:

"Large bat caves are found in the rough limestone region north and west of San Antonio, particularly in Bandera, Medina, Uvalde, Edwards, and Kerr Counties. In some places a good business is done in gathering bat guano for the market. I visited one of these caves near the head of Turtle Creek in Kerr County. We entered the cave at night with lanterns, hoping to secure some bats. There were several hundred in sight flying about when we entered, but they quickly retreated into holes and cracks. We then tried to knock them down outside the cave with sticks and stones, but they all eluded us. There appeared to be two kinds of bats, one much larger than the other. The guano was about three feet deep on the floor of the cave. Although this was a comparatively small cave, we estimated that there were two hundred large sacks full in sight."

**32. Atalapha borealis** (*Müller*). RED BAT.—One adult female, with three young, taken May 13, 1894.

"Quite common; found hanging to the branches of trees. The three young specimens in alcohol were found clinging to the nipples of the mother."—H. P. A.

**33. Atalapha cinerea** (*Beauv.*). HOARY BAT.—One specimen.

"Taken near Cubbra Springs, 18 miles west of San Antonio, by Mr. Steven Kearney, who found it hanging on a hackberry tree. He does not remember the exact date, but is certain it was in the early part of the summer of 1891."—H. P. A.

**34. Vespertilio** sp.?—Three specimens, San Antonio, March 12 and Oct. 11, 1895. Mr. Attwater reports the capture of still another specimen on Nov. 11, 1895, but the species does not appear to be common. It is a large form of the *lucifugus* group.

**35. Scalops texanus** *Allen.* TEXAS MOLE.—Two specimens from the vicinity of San Antonio are not distinguishable from Rockport specimens (see this Bulletin, VI, 1894, pp. 184–186).

"Not nearly so numerous as at Rockport. Found only in sandy soil. They do much damage in vegetable gardens by eating newly-planted seeds. I think the chestnut-orange shade is a feature of the adults, it being less marked, or even quite lacking, in young specimens."—H. P. A.

**36. Notiosorex crawfordi** *Baird.* CRAWFORD'S SHREW.—Represented by a single specimen, "found dead at entrance to a hole at the foot of a mesquit bush, on high land one mile east of San Antonio." Mr. Attwater also states in his notes: "In 1889 I caught several specimens of this Shrew in a hole I dug close to a pond. I have not met with any for several years, except the one here sent, and believe they are much less common than formerly, an opinion also shared by Mr. Watson."

Dr. Merriam also refers (North Am. Fauna, No. 10, Dec., 1895, p. 33) to a specimen received from Mr. Attwater collected at San Antonio in 1890.

**37. Ursus americanus** (*Pall.*). BLACK BEAR.—Represented by a single skull, from the head of the Nueces River.

"Black Bears are still found in localities at the head of the Nueces River, and in the Devil's River region, where the immense and almost impenetrable cedar brakes afford them protection. Ten years ago they were common in parts of Bandera and Kerr Counties. Mr. Lacey informs me that at that time 'Bear bacon' was nearly always to be found at any of the ranches on Turtle Creek, and that it was almost impossible to raise hogs on account of Bears eating the young pigs.

"A pair of Black Bears have bred three times in the Zoölogical Gardens at San Antonio, each time bringing forth the young early in spring. There were three or four in each litter, about the size of rats, and they were eaten by the old ones each time."—H. P. A.

**38. Procyon lotor hernandezii** (*Wagler*). RACCOON.—Two specimens, ♀ ad. and ♂ juv., from the vicinity of San Antonio.

"Common throughout this region, but most often met with along the rivers, where they live in the holes and crevices in the high bluffs. They are very fond of the fresh-water mussels, and eat lizards whenever they can catch them."—H. P. A.

**39. Bassariscus astutus** (*Licht.*). CIVET CAT.—Although not represented by specimens, Mr. Attwater contributes the following:

"More common in the rough country north and west of San Antonio. In captivity they become quite tame, and live comfortably; but I have not heard of their breeding in confinement. In a wild state they live principally on birds and mice, and are said to be expert mice catchers."—H. P. A.

**40. Conepatus mapurito** (*Gmel.*). WHITE-BACKED SKUNK; BARE-NOSED SKUNK.—"I have heard of several being killed here, and Mr. Toudouze, a taxidermist, has a mounted specimen in his collection which was killed on the Medina River, in Bexar

County, and Mr. Lacey informs me that the species is still found in Kerr County, but that it is not common."—H. P. A.

**41. Mephitis mesomelas** *Licht.* TEXAS SKUNK.—Three specimens—a young female about one-quarter grown, Aug. 6, and an adult male, Aug. 16, 1895, from San Antonio. Also an adult male, "caught alive, when about half grown, seven miles south of San Antonio, and kept alive *for eighteen months*" at the San Pedro Springs Zoölogical Garden in San Antonio. Killed Nov. 19, 1895.

The first two specimens are similar to the series already described by me from Oklahoma (this Bulletin, VI, 1894, pp. 188, 189); the other is almost wholly white, but has the long broad tail and general proportions of the Oklahoma specimens. The whole head, except a broad median stripe and a transverse band in front of the ear, is black, as is also the whole throat and fore neck; the rest of the lower surface is white with narrow streaks and small patches of black, most prevalent toward the anal region. Above the only black on the body is a narrow median stripe extending from the middle of the back to the base of the tail, and black hairs, in ill-defined stripes over and posterior to the shoulders. The long hairs of the tail are white at base and terminally, most of them wholly white, but many have the middle third black. Of this specimen Mr. Attwater gives the following measurements: Length, 711; tail (to end of hairs), 375; tail vertebræ, 260; hind foot, 66. Weight, 3½ lbs., of which about one pound was fat.

On the skull the occipital and sagittal crests are well developed, although the animal was, from the above evidence, probably not more than two years old.

**42. Spilogale indianola** *Merriam.* INDIANOLA STRIPED SKUNK.—Two specimens, one "shot at night in the top of a mesquit tree," October 5, 1895, near the city; the other was taken on the Medina River, fifteen miles south of San Antonio. The white markings in both these specimens are pure white instead of creamy white, as is usually the case with specimens from the coast region of Texas (*cf.* this Bulletin, III, 1890, p. 219, and VI, 1894, p. 196).

"Not very common, but apparently more numerous in the rough country north of San Antonio than south of it. The Little Striped Skunks are known here as 'hydrophobia skunks.'"—H. P. A.

At my solicitation Mr. Attwater kindly made inquiries as to the evidence in support of the belief that this species is especially subject to *rabies*, and hence dangerous to human life. As the results of his inquiries, he writes later that "I have as yet no authentic accounts of persons being bitten." He heard of numerous cases, but could find no one having personal knowledge of such facts. He says: "I hear a good many 'yarns,' but as yet nothing reliable. Everybody believes their bite will cause hydrophobia, because everybody else says so, and knows some one who knew some one else that was bitten, etc., etc."

**43. Putorius brasiliensis frenatus** (*Licht.*). BRIDLED WEASEL.—One specimen, ♂ ad., San Antonio, Feb. 12, 1891. Total length, 495; tail to end of hairs, 213; tail to end of vertebræ, 186; hind foot, 51.

"Not common, but occasionally met with in the chaparral and cactus lands, where Wood Rats, Rabbits and Quail abound. They were frequently met with around San Antonio during the great 'Tramp Rat' invasion of 1889–90."—H. P. A.

**44. Taxidea taxus berlandieri** (*Baird*). MEXICAN BADGER.—One specimen, ♀ ad., San Antonio, March 2, 1895. "Weight, 14½ lbs." The white dorsal stripe runs uninterruptedly from the nose to the base of the tail, but is considerably reduced in width over the shoulders.

"Badgers are common in places between San Antonio and the Rio Grande, but it is only during the last few years that I have heard of them in this county. The female sent was killed on March 2. It was run down at night by hounds, while cat hunting, 18 miles southwest of San Antonio. Its stomach contained the remains of a Pocket Mouse, a young Wood Rat, Lizards, etc."—H. P. A.

**45. Canis lupus** (**? nubilis** *Say*). LOBO WOLF; TIMBER WOLF.—"Formerly common in Bexar County, but I have not heard of their occurrence here for several years. They are still found in the broken, hilly country northwest of San Antonio, particularly in Edwards County. They are more cautious than the Coyotes, and disappear as the country becomes more settled and traversed by railroads. They are much more dreaded by the sheep and goat-men than the Coyotes. 'Mr. Lacey says a Coyote kills sheep because he wants something to eat, but that a 'Lobo' kills them just for fun, and generally 'lays out' a dozen or two before he quits. The ranchmen always pay a larger reward for a Lobo than for a Coyote.

"Mr. J. Blackburn Miller, of Newburgh, N. Y., who spends much time hunting in Texas, with headquarters at San Antonio, and a good authority on Texas game, has made some interesting experiments crossing Coyotes and Lobos with some of his dogs. A setter bitch crossed with a male Coyote raised three pups, and a 'Great Dame' or Wulmer bitch crossed with a male Lobo had thirteen pups."—H. P. A.

Since receiving the above, Mr. Attwater has sent me clippings from a newspaper report of the Fourth Annual Convention of the 'Texas Live Stock Association,' held in San Antonio, Jan. 14, 1896. In consequense of "the alarming increase of destructive animals in this State, especially the Loafer or Gray Wolf, and the consequent loss of our stock," it was urged by Mr. Pryor, the President of the Association, that prompt action be taken to secure from the legislature a law "placing a bounty on this one class of depredators." Other speakers referred to the serious loss of stock from the ravages of Wolves and Coyotes, amounting in some instances, it was claimed, to about 10 per cent. a year.

**46. Canis latrans** *Say*. COYOTE.—"Coyotes are common in Bexar County, and come to the outskirts of San Antonio during the night after chickens, etc. We have been favored with a number of visits from them during the present year. In Kerr County and adjoining counties they are the 'thorn

in the side,' of the sheepmen. Mr. Lacey says the Coyotes of that region are different from the Coyotes of the prairies, being much larger. They are believed by the ranchmen to be a cross between the 'Lobo' (Wolf) and the Coyote. Two years ago, when the bounty act was in force, the regular 'Lobo' price was allowed for the large Coyotes of the rocky region to the northwestward of San Antonio.

"A pair of Coyotes in the Zoölogical Garden have bred for the last four or five years. The young are generally born in April, from four to nine in a litter. The male is nearly black; the female of the ordinary color. The young are about half black and half gray, with generally more black ones than gray, *i.e.*, three out of five are black."—H. P. A.

**47. Vulpes fulvus** (*Gmel.*). Red Fox.—Mr. Attwater in his manuscript notes having made reference to the occurrence of this species in Texas, and to the fact of its probable recent introduction from the East, led me to ask for further information on the subject. With his usual readiness to supply information whenever obtainable, he wrote me under date of Dec. 18, 1895, as follows:

"Enclosed is a communication from Mr. T. H. Brown, Secretary of Texas Fox Hunters' Association, Waco, Texas, in reply to my letter to Mr. Seley, to whom I wrote asking for some information in regard to the Red Foxes, mentioned in my last letter. I trust the information will be interesting. It is certainly satisfactory to get authentic and reliable accounts of such circumstances direct from those who first introduced the animals, thereby establishing reliable data for future reference, and I am pleased to think we have been able to do so with so little trouble. You can retain the letter, as I have taken notes from it," etc.

Mr. Brown's letter here follows, and is so detailed and explicit, and so well covers the essential facts of the introduction of Red Foxes into Texas for sporting purposes, that it will take its place in the natural history literature of Texas as a document of permanent historic interest.

OFFICE OF T. H. BROWN,
County Clerk, McLennan Co.,
WACO, TEXAS, *December 9, 1895.*

H. P. ATTWATER, ESQ., San Antonio.

*My Dear Sir :*—I have just been handed a letter by Mr. Seley from you desiring information in regard to "Red Foxes," and will take pleasure in giving you such information as I have. Yes, sir, there is a Texas Fox Hunters' Association, with Dr. John D. Rogers, of Galveston, as President, and myself as Secretary. I was the first to introduce "Red Foxes" into this part of the State. We had exchanged our old time native hounds or, as are usually called, "Pot Lickers," for the Walker dogs from Kentucky, and the Gray Foxes proved themselves no match for these dogs, only being able to run from twenty to forty-five minutes ahead of them. Having the dogs, it became necessary to get game that would give them a respectable race. Accordingly in 1891 I imported from Kentucky and Tennessee 10 Red Foxes and placed them among the Bosque Brakes about four miles above where it empties into the Brazos River. They gradually scattered over a large area of country. The next spring (1892) I again brought in 23 more reds from the older States, planting 13 of them again among the Bosque Brakes and 10 of them on White Rock Creek on the east side of the Brazos River. These foxes afforded us some fine sport, but they too gradually scattered, only a few remaining in the neighborhood of their adopted home, some wandering off through Bosque and Erath Counties. The next spring I only succeeded in getting two reds from the East and planted these on the Bosque, and they remained and are still affording fine races. In the spring of 1895 I again planted 5 reds on the river near Lovers' Leap, where the waters of all the Bosques mingle with the waters of the Brazos. Some of the bluffs here are 300 feet high, and have a great many caves in them, and these last foxes seem well satisfied with their new home. Occasionally I hear of a Red Fox in various parts of this (McLennan) County, and I am satisfied that within a few years they will be as numerous here as in the old States.

I understand that Messrs. Eli and James Rosborough and Capt. T. H. Craig, all of Marshall, Harrison County, some ten or fifteen years since planted quite a number of reds in that, the eastern, part of the State, and occasionally they find them where they have located off some twenty or thirty miles from where originally turned loose.

Dr. John D. Rogers has, I think, during the spring of 1895, planted some six or eight on his Brazos Bottom farms in Brazos and Washington Counties. I would suppose that in all there have been at least 100 Red Foxes imported and planted in the State.

Hoping this information will assist you in your work,

I remain most respectfully,

T. H. BROWN.

**48. Urocyon cinereo-argenteus** (*Müll.*). GRAY FOX.—"Gray Foxes are not very common, and are found generally away from the river bottoms, and in the more heavily timbered parts of the country south of San Antonio. They are perhaps more at home in the broken country north of San Antonio. They are fond of grapes, persimmons, wild cherries, black haws, etc., and are said to eat melons. They are good climbers. Mr. Lacey informs me that his hounds sometimes tree them, and that they go to the tops of the highest trees. He remembers one or two occasions when the fox was 'the highest part of the tree.'

"While we were camped out in the rough country west of Turtle Creek in Kerr County, last December, I had a good opportunity for becoming familiar with the note or noise made by these little foxes. They approached our camp-fire after dark, and from a respectful distance gave vent to their surprise or disgust. From the shape of this beautiful little animal I should certainly have expected to hear some kind of a sharp, ringing bark, like the howl of a small dog or a coyote, but was surprised to hear a hoarse kind of noise, repeated slowly several times with short intervals, more like the coarse note of some bird of prey than the bark of a fox. In fact, at first I took it to be the note of some kind of owl or night bird, with which I was unfamiliar, but Mr. Lacey was well acquainted with it."—H. P. A.

**49. Lynx texensis** *Allen.*[1] TEXAS LYNX.—Two specimens, as follows: No. 10,311, ♂ ad., Watson's Ranch, Medina River, 15 miles south of San Antonio, May 9, 1894; No. 10,310, ♂ ad. (a flat skin), same locality, Feb. 14, 1895. These specimens measure respectively as follows: No. 10,311, length, 913; tail, 190; hind foot, 190; weight, 18¾ lbs. No. 10,310, length, 935; tail, 197; hind foot, 188.

From Mr. Attwater's extended notes on this species, I extract the following:

"The Lynx, or Short-tailed Wild Cat, is common all over this region, but not as numerous as formerly. Its home is among the ravines and dry gullies which run into the creeks and rivers,

[1] *Lynx rufus*, var. *maculatus*, AUD & BACH. N. Am. Quad., II, 1851, 259, pl. xcii. (Not *Felis* (*Lynx*) *vulgaris maculatus* KERR, An. Kingd., I, 1792, No. 297.)
*Lynx texensis* ALLEN, Bull. Am. Mus. Nat. Hist., VII, p. 188, June 20, 1895.

where the land is broken and cut into holes and fissures by heavy rains, and the whole covered with a tangled growth of thorny brush, cacti, yuccas, and small trees, forming a labyrinth which presents to the intruder a thousand thorns at every step, penetrated only by cattle paths leading to water, and where a man found traveling on foot would be considered either an escaped lunatic or a fugitive from justice. Here the Wild Cats used to share the premises with Peccaries, but the latter have been killed out in this county, and their only neighbor now is the rattlesnake.

"Wild Cats are often seen in the daytime, lying on ledges along the river bluff, and on horizontal limbs of trees sunning themselves. Mr. Watson once saw a Wild Cat lying in the water on the Medina River, cooling itself after having been run by dogs. Their food consists chiefly of Wood Rats, Rabbits and Quail. They steal many turkeys and chickens from the ranches, and kill goats and young pigs. On skinning a Wild Cat, the legs, head, neck, etc., are often found to be covered with cactus thorns, where they have accumulated under the skin in large quantities, the cats no doubt obtaining most of the rats, etc., by pouncing on them in their retreats among the bunches of *Opuntia*.

"I have had the pleasure of hunting Wild Cats with Mr. Otto Braubach, a neighbor of Mr. Watson, who has a pack of hounds trained to hunt cats, and have obtained some interesting information from him in regard to their habits. Mr. Braubach hunted Wild Cats for the bounty several years ago, and in less than twelve months, commencing about September, 1892, killed 85 of these cats. They were nearly all killed in a cattle 'pasture' formed by the fork of the Medina and Leon Rivers about twelve miles southwest from San Antonio. A number of other Wild Cats were killed during the same time by other hunters in the same neighborhood. It generally took the hounds about three hours to tire a cat out and 'tree' it or corner it in a cave, and one was once run into the river by the dogs and killed there. The cats would not take to trees or holes on *dark nights*, but kept dodging around in chaparral thicket till they were run down.

"Mr. Lacey reports them common in Kerr County, and from a high place on the side of a cañon he once saw an old one dodging the dogs by following around *after* the hounds that were trailing it among the thickets below him. These cats are often taken while

young and raised as pets, and become very much attached to their owners. They occasionally breed in confinement."—H. P. A.

**50. Felis concolor** *Linn.* PANTHER; MEXICAN LION.—Represented by two skulls and a kitten, which died in the Zoölogical Garden at San Antonio.

"Not as scarce as the Jaguar in the country west of San Antonio, but they are fast becoming killed out. Mr. Otto Braubach saw one on the Medina River in this (Bexar) county two years ago, and Mr. Lacey reports one on Turtle Creek, Kerr County, one year ago. These are the only recent trustworthy records I have.

"The pair of which I sent you the skulls died here in the Zoölogical Garden from having been poisoned. They had given birth to two litters of kittens, of four each—the first, April 4, 1891, the second, June 4, 1892. The period of gestation was observed to be 96 days. They were about six years old."—H. P. A.

**51. Felis onca** *Linn.* JAGUAR.—"Rare east of the Nueces River, but still taken occasionally in the chaparral thickets in the counties bordering the Rio Grande. Said to have formerly occurred in this (Bexar) county."—H. P. A.

**52. Felis pardalis** *Linn.* OCELOT; LEOPARD CAT.—"Common in the vast chaparral thickets between San Antonio and the Rio Grande, but now seldom discovered near San Antonio. Three years ago Mr. Otto Braubach's hounds treed a Leopard Cat near the fork of the Medina and Leon Rivers. This is the only recent authentic record I have for the occurrence of this animal in Bexar County. Mr. Lacey informs me that they are still met with rarely in Kerr County."—H. P. A.

The following species was accidentally omitted in its proper place (p. 57).

**53. Lepus aquaticus attwateri** *Allen.* ATTWATER'S SWAMP HARE.

*Lepus aquaticus attwateri* ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 327. (Published Nov. 10, 1895.)

There is nothing to add to the account of this species already published (l. c.).

# Article VI. — SPECIES OF HYRACOTHERIUM AND ALLIED PERISSODACTYLS FROM THE WAHSATCH AND WIND RIVER BEDS OF NORTH AMERICA.

By J. L. Wortman.

Plate II.

The determination of the species of the Perissodactyla from the Lower Eocene horizons of this country has hitherto been a matter of considerable difficulty, and it has been only after a most careful study of nearly all the known material, that I have been able to come to any definite conclusions regarding their classification and arrangement. At the outset it is necessary to clearly distinguish the genera before undertaking to discuss the species.

In the Wahsatch deposits of this country there are only three genera which clearly belong to the Perissodactyla, although several others have been described. The three well-marked groups of species thus capable of being distinguished and defined are *Heptodon*, *Systemodon* and *Hyracotherium*, all of which are found associated in the same deposits. Three others have been proposed, but it is highly probable that they are either synonyms of one of the three above mentioned, or of doubtful generic value.

Of these latter invalid genera I will consider first the one proposed by Prof. Marsh[1] under the name *Eohippus*, to which he refers two species, *E. validus* and *E. pernix*, the former from the Wahsatch of New Mexico, and the latter from the Wahsatch of the Bear River Beds of western Wyoming. Zittel[2] considers *Eohippus* and *Ectocium*, a genus proposed by Cope from the Wahsatch of the Big Horn Basin, as synonymous, but upon what

[1] Amer. Jour. Sci., Vol. XII, Nov., 1876, p. 401.
[2] 'Handbuch der Paleontologie,' p. 242.

ground he does not state. From Prof. Marsh's description and measurements of the two species of this genus it would appear, at least until some other differences are shown to exist, that *Eohippus validus* is the same as *Hyracotherium vasacciense* of Cope from the same locality. *Eohippus pernix*, according to the measurements and description, corresponds exactly with *Hyracotherium index* of Cope, also from the same locality in which Prof. Marsh's specimen was obtained.

Prof. Marsh has, however, added some important knowledge to the characters of these earliest known horses, more especially as regards the structure of the feet. He has shown,[1] for example, that in *E. validus* the hind foot possessed a vestige of the fifth digit, a structure which had entirely disappeared from the horses of the Wind River Beds. He was the first, moreover, to point out the equine characters of these forms. The question now arises, what is the foot structure of the type of *Hyracotherium?* If it is the same as that described by Marsh in *Eohippus validus*, then *Eohippus* is a *synonym* of *Hyracotherium*, but if it is the same as that described by Cope in *Hyracotherium venticolum*, viz., the absence of this vestigial fifth digit, then the genus *Eohippus* is a good one and must be retained. The only characters upon which we are enabled to form a judgment is the structure of the superior premolars. These in Owen's type of *Hyracotherium*[2] are simple, and correspond closely with the Wahsatch stage of evolution in this country. While in the Wind River horizon, as I will attempt to show presently, there is a decided advance in the structure of one of these teeth, at least, which we know is associated with the disappearance of the vestigial fifth digit from the hind foot, as exemplified in the skeleton of *Hyracotherium venticolum.* From this evidence it seems to me that one is in a measure justified in considering *Eohippus* and *Hyracotherium* as referring to one and the same group of species. There is, however, a constant and important difference between the European and American Hyracotheres seen in the structure of the second superior premolar. In all the American forms which I have seen this tooth has two

[1] Amer. Jour. Sci., Vol. XII, Nov., 1876, p. 401.
[2] Trans. London Geolog. Soc., 2d Series, Vol. VI, p. 203, pl. xxiv.

external cusps, whereas in the European species it is always single, and is therefore more primitive.

I leave for the present the discussion of the propriety of removing those Wind River forms, which exhibit this advanced structure of the premolars and the loss of the vestigial fifth digit, from the genus *Hyracotherium* or *Eohippus*, and giving to them an independent rank of equal generic value.

The next genus to be considered is *Ectocium*, which was originally proposed by Prof. Cope.[1] A careful comparison by Prof. Osborn of the type specimen with some of the smaller species of *Phenacodus* reveals the fact that it undoubtedly pertains to this, or some nearly related genus, and is not a member of the Perissodactyla at all.

The third genus to be considered in this connection is the so-called *Pliolophus*, which is not uncommon in the Wahsatch Beds of the Big Horn Basin. The only character by which it is known to differ from the cotemporary Hyracotheres is the presence of a fourth cusp upon the inner posterior part of the last lower premolar, whereby it is said that this tooth is molariform. According to Earle,[2] who has recently examined Owen's type, *P. vulpiceps*, in the British Museum, the last lower premolar is not entirely molariform. This is really the condition of the majority of the specimens in the American Museum collection which have been referred to this genus, although it is proper to state here that one can find almost every intermediate stage between the complete absence and the presence of a well-defined cusp in this situation. On this account I am inclined to regard this cusp as at most but a subgeneric variation.

Turning now to the three well-established genera from this formation, I will consider first the characters by which they are distinguished from each other. These characters are summarized in the following table.

---

[1] Proc. Amer. Phil. Soc., 1881, p. 182.
[2] American Naturalist, Feb., 1896, p. 132.

TABLE I.—GENERA OF WAHSATCH PERISSODACTYLA.

| *Systemodon.* | *Heptodon.* | *Hyracotherium.* | Sub. gen. *Pliolophus* (?) |
|---|---|---|---|
| (1) 1st superior premolar, either separated by diastema from 2d premolar or teeth in continuous series. | (1) 1st superior premolar always in contact with 2d premolar and separated by diastema from canine. | (1) 1st superior premolar separated by diastema from both canine and 2d premolar. | (1) Same as in *Hyracotherium*. |
| (2) Internal cusps of superior premolars composed largely of single oblique crest, directed forwards and inwards. Outline of crown triangular. No intermediate cusps. | (2) Same as *Systemodon*. | (2) Internal cusps of superior premolars composed of large lunate cusp, with tendency to divide into two cusps. Outline of crown more or less quadrate. Intermediate cusps present. | (2) Same as in *Hyracotherium*. |
| (3) Superior molars with intermediates not distinct, but confluent with internal cusps, forming distinct crests. Posterior external cusps very little flattened externally and little pushed inwards; cross crests low and obtuse. | (3) Superior molars with intermediates completely fused into cross crests. Posterior external cusps flattened externally and much pushed inwards. Cross crests high and cutting. | (3) Superior molars with intermediates not fused with internal cusps into cross crests, but distinct and well separated. Postero-external cusps not flattened externally nor pushed inwards. | (3) Same as in *Hyracotherium*. |
| (4) 1st inferior premolar in contact with canine and separated by diastema from 2d premolar, or (?) in contact with 2d premolar and separated from canine by diastema. | (4) 1st inferior premolar in contact with 2d premolar and separated by diastema from canine. | (4) 1st inferior premolar separated by diastemata from both canine and 2d premolar. | (4) Same as in *Hyracotherium*. In one species diastema absent. |
| (5) Inferior molars with imperfect cross crests notched in centre, connected fore and aft with an oblique ridge. Heel of last molar large. | (5) Inferior molars with perfect cross crests not notched in centre, nor connected by fore and aft oblique ridge. Heel of last molar reduced. | (5) Inferior molars without or with slightly developed cross crests, connected by oblique ridge, as in *Systemodon*. Heel large. Last inferior premolar with single posterior cusps. | (5) Same as in *Hyracotherium*, except last inferior premolar with two posterior cusps. |
| (6) Digits, ?–4. | (6) Digits, 4–3. | (6) Digits, ?–4. | (6) Digits, ?–3. |

## Heptodon *Cope.*

This genus, which is first met with in the Wahsatch and continues in the Wind River Beds, marks the beginning of an important phylum, whose greatest development occurred in the later Bridger and Uinta epochs in America. It is a near relative of *Lophiodon*[1] of the Eocene of Europe, and indeed Cope, who originally proposed the genus, spoke of it as a *Lophiodon* with a full complement of premolars in the upper jaw, whereas *Lophiodon* proper has the first premolar missing.

It differs from its undoubted successor in the Bridger formation, *Helaletes*, in having all the premolars simpler than the molars, while this latter genus has two of the premolars submolariform.

The distinctions between it and *Systemodon*, its Wahsatch cotemporary, while not marked by any very pronounced characters, is still sufficiently clear to fully warrant the generic separation of the two groups. The more important of these characters are as follows: In *Systemodon* the superior premolars and canine either form a continuous series or the first premolar is separated from the second by a diastema, being in contact with the canine. In *Heptodon* the first premolar is always in contact with the second, and there is a considerable diastema between it and the canine. In the superior molars *Systemodon* has rather low obtuse cross crests, while in *Heptodon* these cross crests are much higher, sharper and generally better defined. The postero-external cusps (metacones) of the molars of *Heptodon* are considerably flattened externally and pushed inwards, whereas in *Systemodon* they are pushed but little inwards and are convex externally. In *Heptodon* again the first inferior premolar is in contact with the second, and is separated by a diastema from the canine, whereas in *Systemodon* the first inferior premolar is in contact with the canine and separated by a diastema from the second. It should be stated, however, that the lower jaw of two of the species of *Systemodon* is not known with certainty as regards this character, but from some fragmentary material of *Systemodon semihians* it seems probable that the first lower premolar is placed as in the species of *Heptodon*. I have, therefore, used this character only provisionally. Some further differences are to be seen in the

[1] See Bull. Am. Mus. Nat. Hist., Vol. VII, 1895, p. 361.

lower teeth which serve to distinguish the two genera from each other quite clearly. The cross crests of the lower molars of *Systemodon* are less perfectly developed, and the anterior and posterior crests are always connected longitudinally by an oblique ridge; in *Heptodon* the cross crests are better developed, just as in the superior molars, and the oblique fore and aft ridge is entirely wanting. In *Heptodon*, moreover, the heel of the last molar is much reduced and pointed, while in *Systemodon* it is large, broad and prominent. This reduction of the heel, I take it, is in some way associated with the pushing in of the metacone and shortening of the posterior cross crest of the last superior molar, which is always most pronounced in this tooth, indicating its remote affinity to the Rhinocerotoidea.

As compared with *Hyracotherium*, the position of the first superior premolar in both jaws, the internal cusps of the superior premolars, as well as the structure of the molars, distinguish *Heptodon* at once from this genus. These characters are fully set forth in the foregoing table and need no further mention.

The species of *Heptodon* are not numerous, two having been described by Cope from the Wahsatch and two from the Wind River Beds; one of these, *H. singularis*, is as yet very imperfectly known, and it may prove to belong to another genus. It is from the Wahsatch of New Mexico. The other Wahsatch species, *H. posticus*, is represented by two lower jaws from the Big Horn Beds (Nos. 4687 and 4688), while the two Wind River species, *H. calciculus* and *H. ventorum*, are better known.

The definitions of these species are as follows:

| *H. posticus* Cope.[1] | *H. calciculus* Cope.[2] | *H. ventorum* Cope.[3] | *H. singularis* Cope.[4] |
|---|---|---|---|
| (1) Upper teeth unknown. | (1) 2d upper premolar with single external cusp. | (1) 2d upper premolar with two external cusps. | (1) 2d upper premolar unknown. |
| (2) 4th lower premolar with single posterior cusp. | (2) 4th lower premolar same as in *H. posticus*. | (2) 4th lower premolar with two posterior cusps. | (2) Lower teeth unknown. |
| (3) Length of 3 lower molars and 3 lower premolars, 62 and 66 mm. | (3) Length of 3 lower molars and 3 lower premolars? | (3) Length of 3 lower molars and 3 lower premolars? | (3) Unknown. |
| (4) Upper molars unknown. | (4) Length of upper molars and 3d and 4th premolars, 48 mm. | (4) Length of upper molars and 3d and 4th premolars, 47 mm. | (4) Length of upper molars and 3d and 4th premolars, 32 mm. |

[1] Proc. American Philos. Soc., 1881, p. 187. Am. Nat., 1882, p. 1029.
[2] Am. Nat., 1880, p. 747. [3] Am. Nat., 1880, p. 747. [4] Wheeler Surv., IV, ii, pl. lxvi.

As already remarked, the larger Wahsatch species, *H. posticus*, is known from two lower jaws, which differ somewhat from each other in size. The smaller of these (No. 4688) Cope referred to *H. ventorum*, but it differs from this species not only in the simpler fourth premolar of the lower jaw, but in the less elevated and more obtuse crests of the molars. From *H. calciculus* it differs, so far as we now know, only in size, but, considering the wide separation in point of time, there can be little doubt that other important differences will be found when we know more of its skeleton. For a fuller description of the Wind River species I must refer the reader to Prof. Osborn's paper[1] as well as the work of Prof. Cope.[2]

## Systemodon *Cope.*

The species of this genus have thus far been found only in the Wahsatch. The distinctions between it and *Heptodon* have already been fully considered. Its morphological position, so far as I am able to judge from the fragmentary material by which it is represented, is intermediate between that of *Heptodon* and *Hyracotherium*. With the exception of the position of the

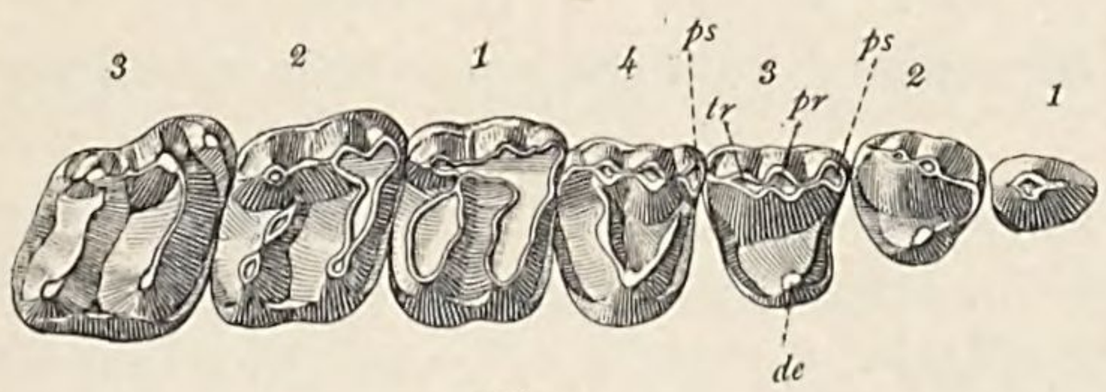



Fig. 1.

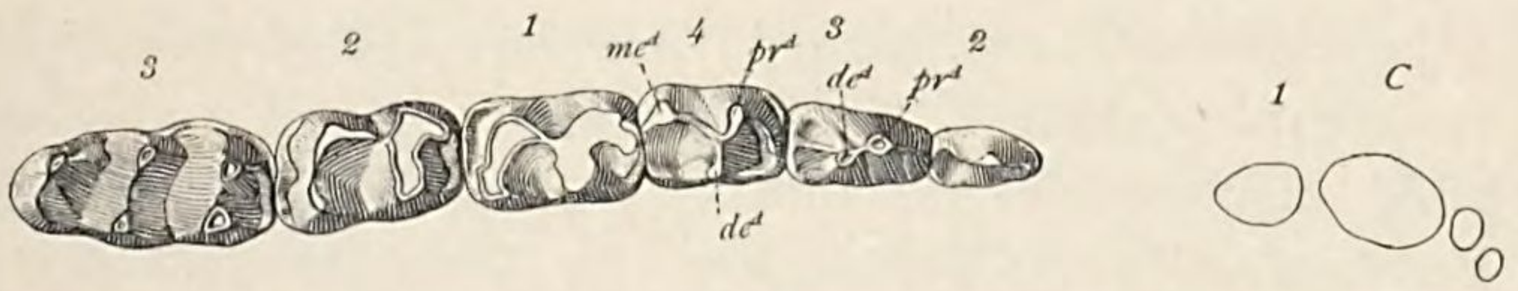



Fig. 2.

Figs. 1 and 2. *Systemodon protapirinus.* Type specimen, No. 4460, Wahsatch Beds, Big Horn, Wyoming. Natural size.

Fig. 1. Upper teeth, crown view. ABBREVIATIONS: *pr.*=protocone, *de.*=deuterocone, *tr.*=tritocone, *ps.*=parastyle.

Fig. 2. Lower teeth, crown view. ABBREVIATIONS: $pr^{d.}$=protoconid, $de^{d.}$=deuteroconid, $me^{d.}$=metaconid.

[1] Bull. Amer. Mus., Vol. IV, Oct., 1892, p. 128, in which the foot structure of *H. calciculus* is described.

[2] Tertiary Vertebrata, p. 656.

first lower premolar, it exhibits all the characters which we would be led to look for in the ancestor of *Heptodon*. This latter character, it is proper to remark, is not known with certainty except in one species, and it may yet prove that one of the other species fulfills all the requirements of the ancestral species.

*Systemodon* differs from *Hyracotherium* in the following characters: In *Hyracotherium* the first premolar in both jaws is separated by a diastema from the canine in front and the second premolar behind; in *Systemodon*, as we have already seen, it varies with the species. The internal cusps of the superior premolars in *Systemodon* consist of oblique crests without intermediates, while in *Hyracotherium* these cusps are large and lunate, with a tendency to divide into two, always associated with intermediates in some of the premolars. In *Hyracotherium* the outline of the crowns of the third and fourth premolars are more quadrate than in *Systemodon*, because of the large lunate internal cusp. In the upper molars of *Systemodon*, the intermediates are fused with the internal cusps, so as to form cross crests, while in *Hyracotherium* the intermediates are perfectly distinct. The same cresting of the lower molars is seen in *Systemodon*, but while some species of *Hyracotherium* show a marked tendency in this direction they are never so fully crested as in *Systemodon*.

In the foregoing table of the generic characters, mention has been made of the foot structure of the several genera. This is well known in *Heptodon*[1] and *Hyracotherium*, but that of *Systemodon* has hitherto been unknown. I will merely mention here that so far as the hind foot is concerned, *Systemodon* resembles *Heptodon* to a remarkable extent. This likeness is seen in the compressed elongated character of the foot as well as in the great length and slenderness of the phalanges. In *Hyracotherium* the phalanges are short, a character which distinguishes them at a glance. In *Systemodon* there was at least a vestige of a fifth digit, and so far as one is able to judge from the material, I am inclined to the opinion that this digit was complete.

Three species are known with certainty, all of which are from the Wahsatch. They are defined as follows:

[1] Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 128.

| *S. protapirinum*,[1] sp. nov. | *S. primævus*, sp. nov. | *S. semihians* Cope. |
|---|---|---|
| (1) Premolars and canine in continuous series in upper jaw. (2) Second superior premolar with strong internal cusps. | (1) Premolars and canines in continuous series in upper jaw. (2) Second superior premolar without internal cusp. | (1) A diastema between 1st and 2d superior premolars. (2) Second superior premolar with small internal cusp. |

**Systemodon primævus,** sp. nov.

This species is indicated in the collection by two fragments of skulls (Nos. 144, 147) supporting the entire superior dentition. There are several other skull fragments in the collection which doubtless pertain to the same species, but the characteristic second premolar is not sufficiently preserved to determine this point with certainty.

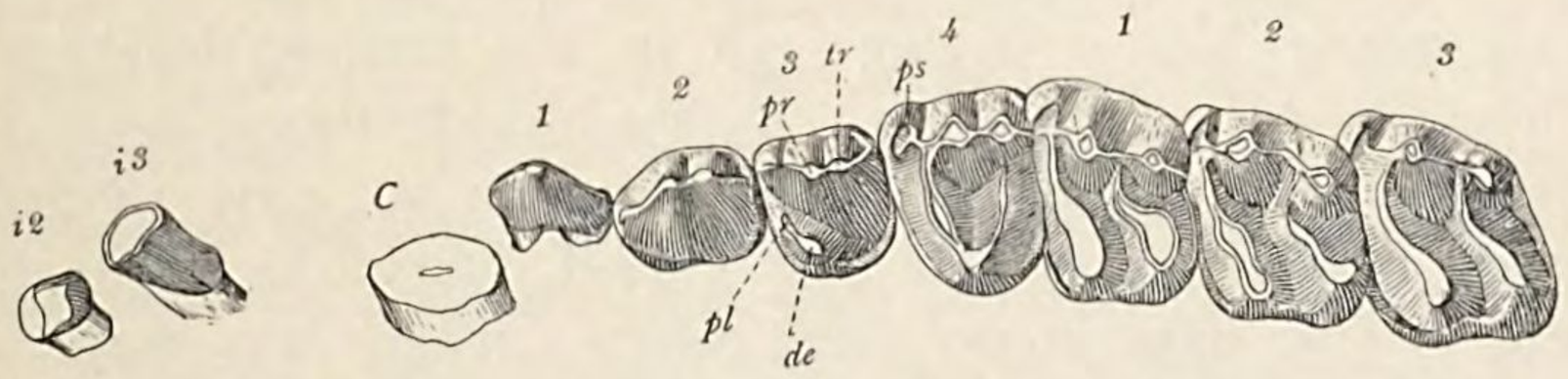



Fig. 3. *Systemodon primævus.* Upper teeth, crown view (type specimen, No. 144). Wahsatch Beds, Big Horn, Wyoming. Natural size. ABBREVIATIONS: *pr.*=protocone, *de.*=deuterocone, *tr.*=tritocone, *pl.*=paraconule, *ps.*=parastyle.

The specimen which I select as the type of the species is No. 144; it includes the two superior maxillaries and premaxillaries containing all the teeth. The structure of the superior molars and premolars, as well as the absence of diastema, refer it to *Systemodon* without question.

As compared with *S. protapirinum* it exhibits the same size and otherwise resembles it closely in every way except in the structure of the second superior premolar. In *S. primævus* this tooth has no internal cusp, whereas in *S. protapirinum* there is a strong internal cusp. From *S. semihians* it is readily distinguished by the presence of a considerable diastema between the first and second superior premolars in this latter species.

[1] The type of this species was originally referred to *Hyracotherium*, and afterwards to *Systemodon*. I find that the original generic reference was correct, and that this species requires a new name, which I here give to it.

The principal measurements are as follows :

| | MM. |
|---|---|
| Length of premolar and molar series | 63 |
| Length of premolars | 32 |

A fairly well-preserved specimen of a hind foot (No. 234) of a species of *Systemodon* is preserved in the collection, which it is proper to describe in this connection.[1] Although it is accompanied with nearly all the teeth of the lower jaw, the characteristic parts of the upper jaw are not preserved, the only means known at present by which the species can be determined with certainty. The lower jaw agrees very closely with that of *Systemodon protapirinum*, and it is highly probable that the specimen belongs to this species.

The general character of the foot is strikingly like that of *Heptodon;* this is especially seen in its comparative slenderness, the form of the astragalus, the calcaneo-fibular facet, the elongated metapodials, and above all in the extreme length and slenderness of the phalanges. As has already been shown[2] the astragalus and calcaneum of *Heptodon* are so very decidedly equine in appearance that it is indeed difficult to distinguish them at first sight in the three genera. There is a character, however, which was originally pointed out by Prof. Osborn,[3] viz. : the union or confluence of the ectal and sustentacular facets of the astragalus in all the Perissodactyla with the exception of the horses, which I find holds good in the Perissodactyla of the Wahsatch. *Heptodon* and *Systemodon* agree in having these facets confluent, while in the horses these facets are separated from each other.

The relations of the tarsal elements are very similar to those of *Heptodon*, as are also the characters of the bones themselves. One point of especial interest is the number of digits. Besides the usual three, the fourth metapodial exhibits a well-marked facet upon the posterior surface of its proximal end, which undoubtedly served for the articulation of the fifth metapodial. It may be that this metapodial was only vestigial in character, a

[1] Mention of this specimen has already been made in a former paper in the Museum Bulletin. See Art. XI, Vol. V, p. 170.

[2] Bull. Amer. Mus., Vol. IV, Article XI, 1892, p. 128.

[3] Mammalia of the Uinta Formation.

fact which would seem to be indicated by its having lost all connection with the cuboid. The exact length of the metapodials cannot be determined on account of their damaged condition, but enough is indicated to state that the foot was relatively long and slender. Several phalanges are preserved, and, as already remarked, their chief peculiarity consists in their great length. No ungual phalanges are known.

## Hyracotherium *Owen.*

The differences between this genus and its two Wahsatch cotemporaries, *Systemodon* and *Heptodon*, have already been considered; it now remains to compare it with its successors in the Wind River and Bridger epochs. I have already called attention to the fact that certain of the Wind River forms show a marked advance in the structure of the third superior premolar, which we know to be associated with the loss of the vestigial fifth digit in the hind foot. This conclusion, it may be stated, is not based upon a single specimen, but upon at least two, in which it can be determined with certainty (Nos. 4832 and 4848). We have then two trenchant morphological characters, modifications which point strongly in the direction of the subsequent changes which the horses underwent in later times.

According to all customs of palæontological nomenclature the Wind River type exhibiting these characters should be separated as a distinct genus, and although it may seem unwise to still further complicate the already overcrowded list of generic names for these early horses, yet I am strongly of the opinion that it is really necessary if we wish to truly express with our nomenclature the major and minor changes to which this steadily advancing phylum was subjected.

Additional characters which distinguish the more advanced Wind River species from the Wahsatch forms are seen in the subcrescentic form of the outer cusps of the superior molars, as well as the lengthening of all the cusps of these teeth, the presence of a rudimentary mesostyle and the appearance for the first time of a small but distinct hypostyle. Upon these characters, therefore, I propose a new genus, which may be known as *Protoro-*

*hippus*. The Eocene genera of the American Equidæ may then be defined as follows :

TABLE II.—GENERA OF AMERICAN EOCENE HORSES.

| *Hyracotherium.* (*Eohippus.*) (Wahsatch.) | *Protorohippus*, gen. nov. (Wind River.) | *Orohippus.* (*Pachynolophus*) (Bridger.) | *Epihippus.* (Uinta.) |
|---|---|---|---|
| (1) A vestige of the fifth digit in the hind foot. | (1) No vestige of the fifth digit in the hind foot. | (1) Same. | (1) Same. |
| (2) Outer cusps of superior molars subconic. | (2) Outer cusps of superior molars subcrescentic. | (2) Outer cusps of superior molars subcrescentic. | (2) Same. |
| (3) No trace of mesostyle. | (3) Rudimental mesostyle. | (3) Mesostyle complete. | (3) Same. |
| (4) No trace of hypostyle. | (4) Rudimental hypostyle usually present. | (4) Hypostyle stronger. | (4) Hypostyle well developed. |
| (5) Third superior premolar with three well developed cusps and only a trace of the fourth cusp. | (5) Third superior premolar with four well-developed cusps. Second superior premolar with external cusp. | (5) Third and fourth superior premolars molariform. Second superior premolar tritubercular, with an internal cusp. | (5) Third and fourth superior premolars molariform. Second superior premolar submolariform. |

I have here used the names *Orohippus* and *Pachynolophus* as possibly synonymous, as has been done by Zittel and Osborn. I do not know the type of *Pachynolophus*, and it is apparently not at all certain to what species it was originally applied. If Rütimeyer has correctly referred his specimen of an upper jaw to *Pachynolophus sideroliticus*, or if Kowalewsky has properly identified and figured the upper molars and premolars of *Pachynolophus desmaresti*,[1] then it would seem certain that the course of the evolution of the superior premolars has been very different in the European and American species of the corresponding stage of development, and that these two series represent

[1] See Zittel's ' Handbuch der Paleontologie ' for figures of *P. sideroliticus* and *P. desmaresti*, p. 242, 243.

distinct phyla. If this supposition is true, then the genus *Pachynolophus*, as understood by European authors, does not occur in the Eocene deposits of this country, and its corresponding stage of evolution among the American horses is represented by the genus *Orohippus* of Marsh.

GEOLOGICAL DISTRIBUTION OF THE HYRACOTHERES.

| | WAHSATCH. | | | WIND RIVER. | BRIDGER. | UINTA. |
|---|---|---|---|---|---|---|
| | N. Mex. | Big Horn. | Bear River | | | |
| Hyracotherium cristatum | | × | | | | |
| " vasacciense | × | × | | | | |
| " tapirinum | | | | | | |
| " craspedotum | | | | × | | |
| " index | × | × | × | | | |
| H. (Pliolophus) cristonense | × | × | | | | |
| " montanum | | × | | | | |
| Protorohippus venticolum | | | | × | | |
| Orohippus | | | | | × | |
| Epihippus | | | | | | × |

The discrimination of the species of *Hyracotherium* is indeed a difficult task, owing partly to the very imperfect specimens that were used by Cope as types in the original descriptions of the species, and partly to the wide limits of individual variation that must be admitted in these forms. My own specific determinations are based upon the materials contained in the American Museum collections, together with the types of Cope's species from the Wahsatch of New Mexico, preserved in the National Museum. Unfortunately I have not been able to include Prof. Marsh's material from the New Mexican and Wyoming Wahsatch, but as he has described only two species from this horizon, already alluded to above, I feel reasonably certain that the more important modifications are included in the subjoined table. The characters of the species are as follows:

TABLE III.—SPECIES OF WAHSATCH AND WIND RIVER HYRACOTHERES.

| *H. tapirinum* Cope. | *H. cristatum*, sp. nov. | *H. craspedotum* Cope. | *H. vasacciense* Cope. | *H. index* Cope. |
|---|---|---|---|---|
| (1) Length of third and fourth premolars and lower molars, 49 mm. | (1) Length of third and fourth premolars and lower molars, 49.5 mm. | (1) Length of third and fourth premolars and lower molars, 49 mm. | (1) Length of molars and third and fourth lower premolars, 38 mm. | (1) Length of third and fourth premolars and lower molars, 38, 36, 32 and 31 mm. (type). |
| (2) Third lower premolar with two anterior cusps. | (2) Third lower premolar with single anterior cusp. | (2) Third lower premolar with two anterior cusps. | (2) Third lower premolar with single anterior cusp. | (2) Third lower premolar with two anterior cusps. |
| (3) Heel of last lower molar small; tooth relatively short and broad. | (3) Heel of last lower molar large; tooth long and narrow. | (3) Heel of last lower molar large; tooth relatively broad. | (3) Heel of last lower molar small; tooth relatively short and broad. | (3) Heel of last lower molar large; tooth long and narrow. |
| (4) Posterior cusps of last lower molar separated by deep notch. | (4) Posterior cusps of last lower molar connected by cross crest. | (4) Posterior cusps of last lower molar separated by deep notch. | (4) Same. | (4) Same. |

## Hyracotherium tapirinum[1] *Cope.*

*Systemodon tapirinum.*

This is one of the largest species of all the Wahsatch Hyracotheres. It was originally described by Cope from the Wahsatch of New Mexico from two fragments of lower jaws. One of these (1064, Nat. Mus. Coll.) contains the last two molars, but is in such a very worn and damaged condition as to be practically valueless for the determination of the characters of the species. A second fragment (1083, Nat. Mus. Coll.), containing the second molar in a good state of preservation however, shows the characters much better, and demonstrates beyond any doubt that it belongs to *Hyracotherium* and not to *Systemodon*, as Cope afterwards concluded, and has subsequently referred it. Additional material, including nearly all the upper and lower teeth with the exception of the upper and lower incisors and canines, is

[1] Cat. Eoc. Vert. New Mexico, 1875, p. 20. Amer. Nat., 1881, p. 1018. Tert. Vertebrata, p. 619 (referred to *Systemodon*).

now contained in the collections of the Museum, which permit of a fuller determination of the species.

These materials are (1) a fragment of lower jaw supporting the last two molars (No. 143*a*); (2) upper and lower molars of both sides, together with lower premolars 3 and 4, and the fourth upper premolar (No. 4657); (3) a palatal portion of a skull containing all the molars, together with the third and fourth premolars (No. 212); and (4) upper and lower molars associated with second superior premolar (No. 139). Since no one specimen gives all the characters of the dentition, the accompanying drawing has been constructed from these several specimens.

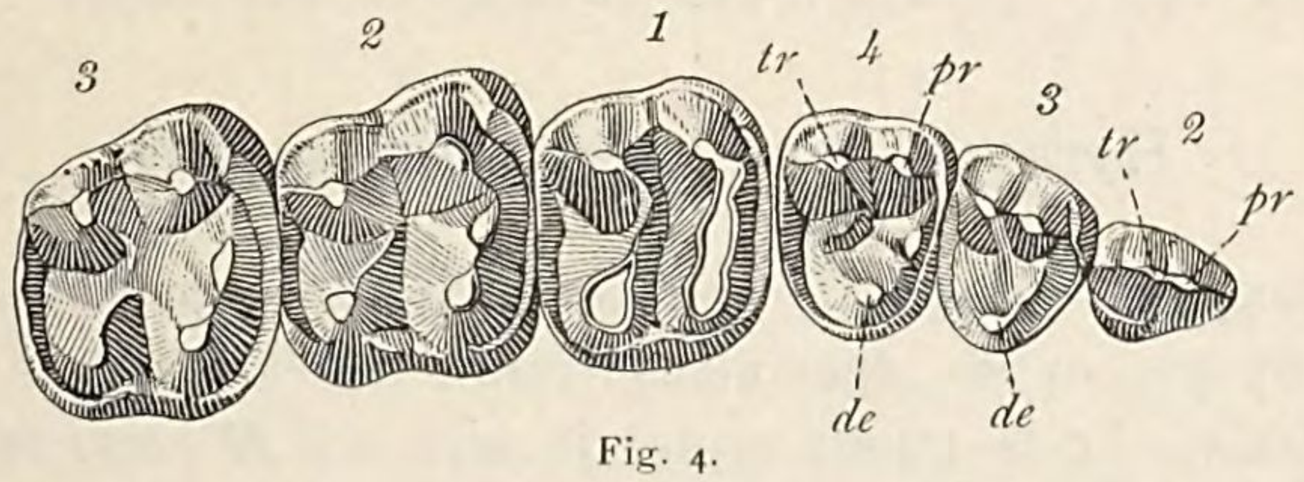



Fig. 4.

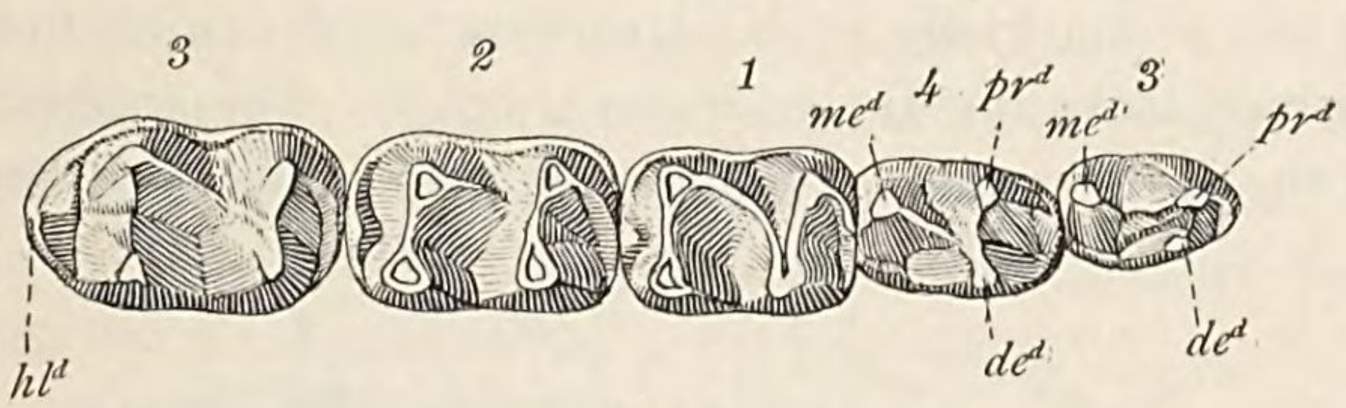



Fig. 5.

Figs. 4 and 5. *Hyracotherium tapirinum.*

Fig. 4. Upper teeth, crown view (composition from Nos. 139 and 212). Wahsatch, Big Horn. X $\frac{4}{3}$.

Fig. 5. Lower teeth, crown view (composition from Nos. 143*a* and 4647). Wahsatch, Big Horn. X $\frac{4}{3}$.

ABBREVIATIONS: *pr.*=protocone, *de.*=deuterocone, *tr.*=tritocone, *pr^d.*=protoconid, *de^d.*=deuteroconid, *me^d.*=metaconid, *hl^d.*=hypoconulid.

The *characters of the species* are as follows: Species large; the length of the lower molars and premolar 3 and 4, 49 mm. The heel of the last lower molar is relatively small and conic, and the cross crests are well developed with the exception of that connecting the two posterior cusps of the last molar, which are separated by a deep notch. The second lower premolar has a well-developed second anterior cusp. The antero-internal cusps of the lower molars are not bifid at their extremities. In the upper molars the intermediates are hardly as distinct as in some

of the smaller species; the fourth superior premolar has very distinct intermediates, and the second displays two distinct external cusps. The measurements of the teeth are as follows:

| | | MM. |
|---|---|---|
| Length of the 3d and 4th premolars and three lower molars | .. | 49 |
| " last lower molar | ..... | 13 |
| " molars 1 and 2 | ..... | 21 |
| " 3d and 4th lower premolars | ..... | 15 |
| " upper molars and premolars 2, 3 and 4 | ..... | 51 |
| " upper molars | ..... | 32 |
| " upper premolars 2, 3 and 4 | ..... | 19 |

The species is so far known from the Wahsatch of New Mexico and the Big Horn Basin, Wyoming. The specimens referred to it are Nos. 139, 143*a*, 212, 4598, 4650, 4651, and 4657.

## **Hyracotherium cristatum,** sp. nov.

This large species of *Hyracotherium* is represented in the collection by five or six specimens from the Wahsatch of the Big Horn Basin. It is about equal in size to *H. tapirinum*, but differs from it markedly in the structure of the third lower premolar, which lacks the antero-internal cusp. The antero-internal cusp of the fourth premolar is also much less developed, and has a

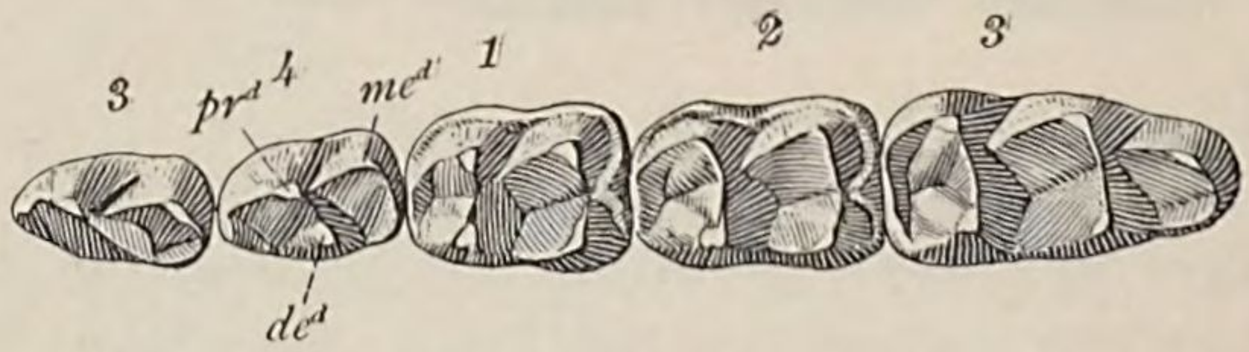



Fig. 6. *Hyracotherium cristatum.* Lower teeth, crown view (composition from Nos. 240 and 248B, Type specimens). Wahsatch Beds, Big Horn. X ⅓.

more posterior position than in *H. tapirinum.* The heel of the last molar is relatively much larger, the cusps are more elevated, and the antero-internal cusps of the lower molars are slightly bifid. The cross crests of the lower molars are well developed, that between the posterior cusps of the last molar being as well developed as the others.

Two superior molars associated with lower molars are contained in the collection, which serve to demonstrate that it belongs to *Hyracotherium* and not to *Systemodon*, as the extreme cresting of

the lower molars would seem to indicate. The superior premolars are unknown. The measurements are as follows :

| | MM. |
|---|---|
| Length of 3d and 4th lower premolars and molars..... | 49.5 |
| " last lower molar..... ..... | 14.5 |
| " molars 1 and 2..... | 20 |
| " premolars 3 and 4..... ... | 15 |

The *type* of this species consists of two specimens, one (No. 258*b*) a fragment of a lower jaw bearing the first and second molars, and the third and fourth premolars, and another, a fragment of a lower jaw (No. 240) containing the last molar; both from the Wahsatch of the Big Horn Basin. To it may also be referred Nos. 4653–6, from the same locality.

## Hyracotherium craspedotum[1] *Cope.*

Cope's *type* of this species consists of a lower jaw (No. 4830), one side containing the three molars and a part of the last premolar, the other side containing premolars 2 and 4 with the first molar, from the Wind River Basin. There is also a skull (No. 4831) in the collection from the same horizon which contains nearly all the upper teeth with the exception of the incisors and canines; notwithstanding that it is somewhat smaller than the type it has been referred to the same species.

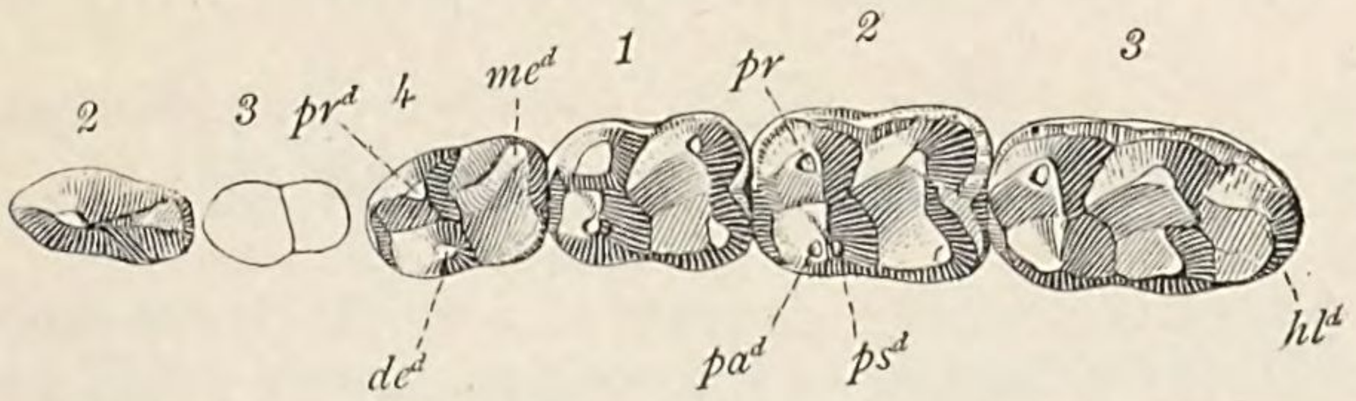



Fig. 7. *Hyracotherium craspedotum.* Lower teeth, crown view (type specimen, No. 4830). Wind River Beds, Wyoming. X $\frac{4}{3}$.

The characters of this species indicate that it is closely related to, and very probably the direct successor of, *H. tapirinum* of the Wahsatch. Unfortunately the third lower premolar is not preserved, so it is impossible to say whether it agrees with *H. cristatum* or *H. tapirinum* in the structure of this tooth. It is more than probable, however, that it will be found to agree with

[1] Amer. Nat., 1880, p. 747; Tert. Vert., p. 631.

the latter of these species in this character, since the presence of this antero-internal cusp constitutes an advance in the structure of the premolars, and it would be remarkable indeed if a Wind River species were so backward in this particular as to have this cusp lacking.

It differs considerably from *H. tapirinum* in the size of the heel of the last lower molar, which is large, and inclined to be more or less basin-shaped. It also differs from this species in having a much greater width of the lower molars in proportion to their length. The extreme, among the large species, of the long and narrow lower molars is seen in *H. cristatum*. The cusps of the lower molars of the species under consideration are low and obtuse, and the cross crests are but very little developed—an additional character which distinguishes it sharply from *H. cristatum*. The antero-internal cusps of the lower molars are slightly bifid at their extremities, presenting a parastylid. The superior molars do not present any differences worthy of note from those of *H. tapirinum*.

The measurements are as follows:

| | MM. |
|---|---|
| Length of 3d and 4th premolars and lower molars..... | 49 |
| " last lower molar..... | 14 |
| " molars 1 and 2..... | 19.5 |
| " premolars 3 and 4..... | 15.5 |
| " superior molars and 3d and 4th premolars..... | 42 |

## Hyracotherium vasacciense[1] *Cope.*

The *type* of this species consists of a single lower molar (No. 4658) from the Wahsatch of New Mexico, which I take to be the




Fig. 8. *Hyracotherium vasacciense.* Lower teeth, crown view (No. 4659). Wahsatch Beds, Big Horn Valley, Wyoming. X $\frac{4}{3}$.

[1] Proc. Am. Phil. Soc., 1872, p. 474; Tert. Vert., p. 634.

second. It is wholly uncharacteristic, and the reference of any additional material to it is, according to the very nature of the case, attended with uncertainty. Cope subsequently obtained other material more characteristic which he referred to this species,[1] and distinguished the species by the depth of the ramus. This character I find is exceedingly variable, and appears to be in a large measure dependent upon the age of the individual. If we are to accept Cope's determinations, then, in my judgment, the species will have to be abandoned, since there are no means discoverable, with the present material at least, by which it can be distinguished from *H. index*. There is in our collection from the Big Horn an almost complete jaw (No. 4659) containing all the molars, together with the third and fourth premolars, which I prefer to take as representing this species. I do this for three reasons, viz.: (1) It agrees quite as well with the uncharacteristic type as does any other specimen which has been referred to it; (2) by so considering it the species is capable of definition, and (3) the proposing of a new specific name will be avoided.

The *character of the species* thus considered would then be as follows: The ramus is remarkable for its great depth in comparison with the size of the teeth; the third lower premolar is without the antero-internal cusps; the last lower molar is unusually short and broad with a relatively small heel. The measurements are:

| | MM. |
|---|---|
| Length of 3d and 4th premolars and lower molars | 38 |
| " last lower molar | 10 |
| " molars 1 and 2 | 15 |
| " premolars 3 and 4 | 13 |

Beside those already mentioned, two other individuals, Nos. 4660 and 4661, are referred to this species.

## Hyracotherium index[2] *Cope.*

Under this heading I arrange all the specimens which Cope has referred to *H. index*, *H. angustidens*, *H. cuspidatum*, all, in fact,

[1] Wheeler Surv. Rep., Vol. IV, Part ii, p, 264.
[2] Bull. Hayden Surv., 1873, p. 459; Wheeler Surv. Rep., IV, Pt. ii, p. 262; Tertiary Vert., p. 650.

except the type, which he has referred to *H. vasacciense*, as well as all the *Wahsatch* specimens classified under the name of *H. venticolum*. I also place here Cope's specimens identified as *Orotherium vintanum* (Marsh) from the New Mexican Wahsatch. The

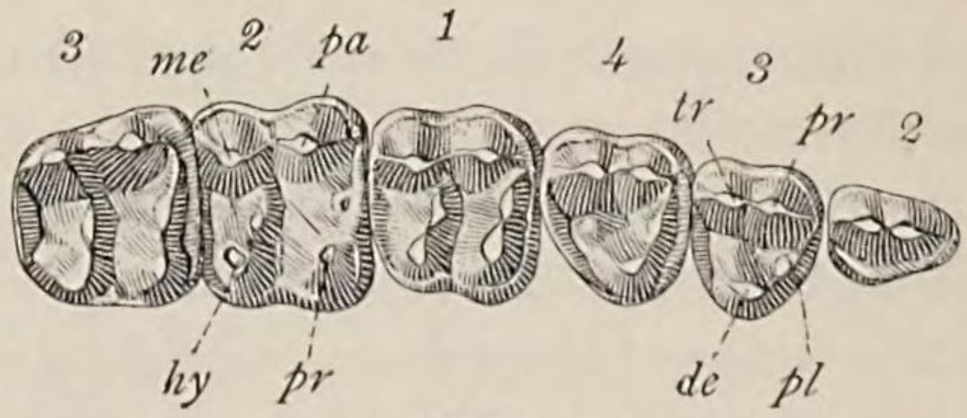



Fig. 9.

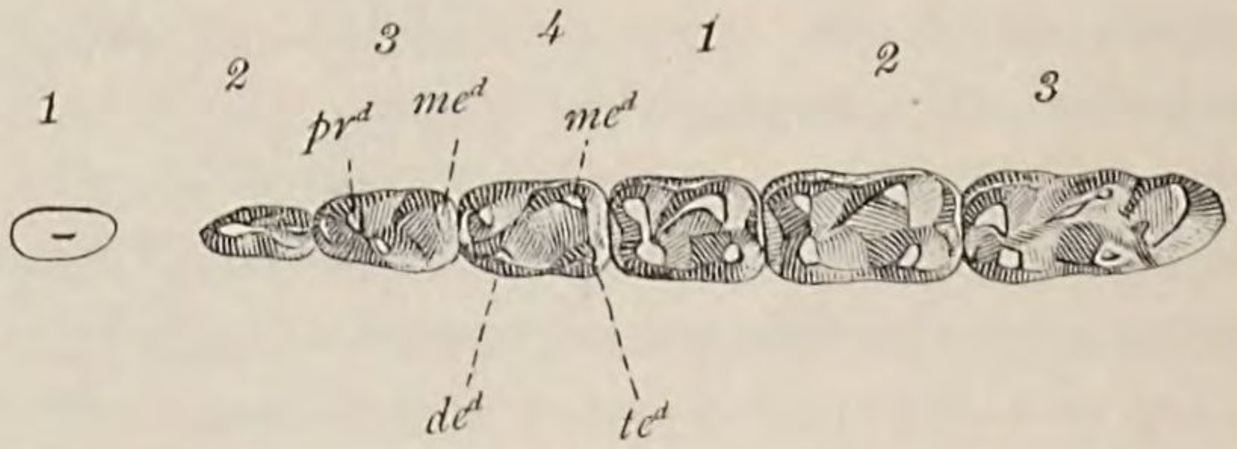



Fig. 10.

Figs. 9 and 10. *Hyracotherium index.*

Fig. 9. Upper teeth, crown view (No. 4602). Wahsatch Beds, Big Horn Valley, Wyoming.
Fig. 10. Lower teeth, crown view (No. 4613). Wahsatch Beds, Big Horn. X $\frac{4}{3}$.

type of this latter species was originally described by Marsh from specimens found on Henry's Fork in the Bridger Basin, and it is very much more probable that it belongs to *Orohippus* than to *Hyracotherium*.

In bringing together all of these so-called species I am sensible of the fact that it associates individuals which differ from each other considerably in the matter of size and the depth of the ramus, but there are such perfect gradations in this respect among the large number of individuals which we now possess, that I find it utterly impossible to make any valid distinctions, and it is perhaps better to err on the side of safety and have too few species than to admit a larger number which cannot be defined.

The species thus constituted exhibits a very great constancy in the structure and proportions of the teeth, from which it is almost exclusively known. The *specific characters* may be summarized as

follows : The third lower molar is very long and narrow in proportion to its width ; the heel is large, prominent, and has but a single pointed cusp. The cusps of the lower molars are well separated, with very little tendency to form crests, and the third lower premolar has two anterior cusps. There is a very considerable difference in size, together with marked differences in the depth of the mandibular ramus, but, as already remarked, this latter character is in some measure due to the age of the individual.

The species is at once distinguished from *H. vasacciense* and *H. cristatum* by the more complex character of the third lower premolar ; from *H. tapirinum* it differs not only in size, but in the much narrower and relatively longer last molar, the relative size of the heel of this tooth, and the degree of separation of the cusps of all the lower molars. From *H. craspedotum* it can readily be distinguished by the much smaller size, and the general narrowness of the lower teeth in proportion to their width. In *H. craspedotum*, moreover, the cusps are much more robust and less elevated. The following measurements indicate the range in size of the individual :

| | MM. | MM. | MM. | MM. | MM. | MM. |
|---|---|---|---|---|---|---|
| | | | | | | TYPE. |
| Length of premolars 3 and 4 and lower molars..... | 36 | 32 | ..... | ..... | 38 | 31 |
| Length of last lower molar..... | 09 | 10.5 | 12 | 10 | 09.5 | 09 |
| " molars 1 and 2. ..... | 14.5 | 14 | 17.5 | 15 | 16.5 | 11.5 |
| " premolars 3 and 4..... | 12 | 12 | ..... | ..... | 12 | 10 |

All of the foregoing species of *Hyracotherium* are readily distinguished from the European species *H. duvali* and *H. leporinum*, by the greater simplicity of sup. pm. 2, which in these latter species has but a single external cusp. In all the American species this tooth has two external cusps. It may yet be found that there are other important differences between these groups which will necessitate recognizing a separate genus for the American forms, in which event the name *Eohippus*, proposed by Marsh, would have to be adopted.

## Subgenus **Pliolophus** *Owen.*

As already remarked, this is a genus of very doubtful validity. A number of specimens occur in our collections in which the fourth lower premolar has a more or less distinct fourth cusp. In no instance in which I have observed it, however, can this tooth be said to be fully molariform, almost all degrees of distinctness being met with. With few exceptions these specimens agree in every respect with *H. index*, and whether they are to be regarded as of generic importance, or are best treated as specific variations, is a question difficult to determine. From the very great similarity between these specimens and those of *H. index*, as well as the great variability in the size of the cusp in question, one is almost tempted to believe that they are only individual variations of this species. I will consider them here under the subgeneric title *Pliolophus*.

### **Hyracotherium (Pliolophus) cristonense**[1] *Cope.*

The type of this species consists of an almost entire mandible lacking only the posterior portion (No. 1002, Nat. Mus. Coll.); it

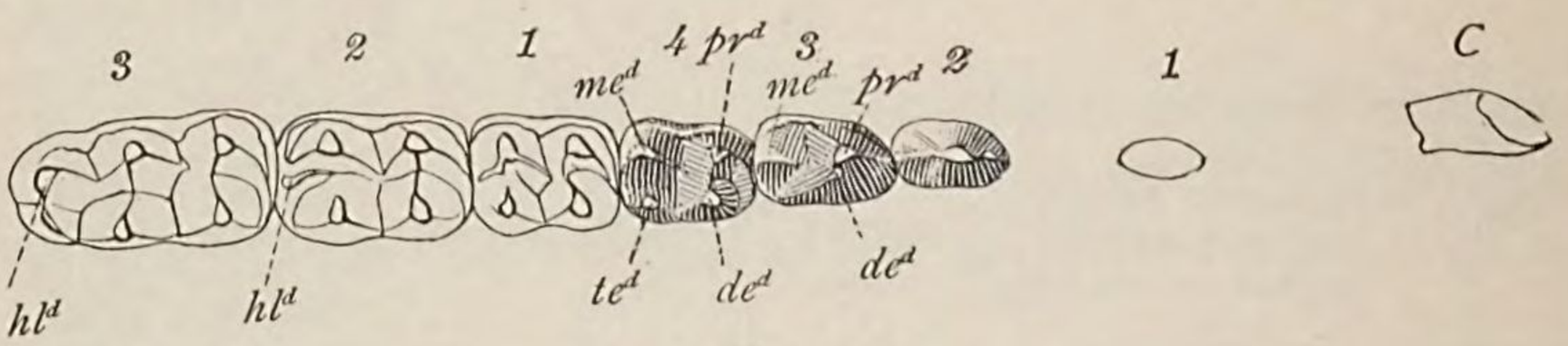



Fig. 11.

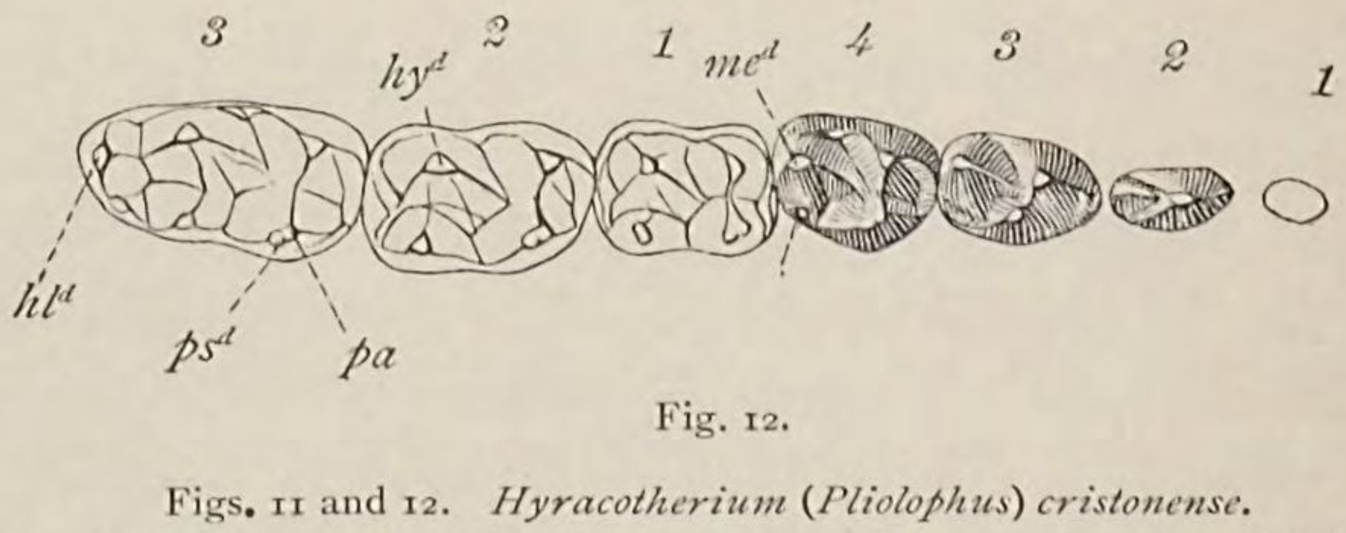



Fig. 12.

Figs. 11 and 12. *Hyracotherium* (*Pliolophus*) *cristonense.*

Fig. 11. Lower teeth, crown view (type specimen, No. 1002 Nat. Mus. Coll.). Wahsatch Beds, New Mexico. X $\frac{4}{3}$.

Fig. 12. Lower teeth, crown view (No. 165). Wahsatch Beds, Big Horn. X $\frac{4}{3}$.

[1] Wheeler Surv. Reports, IV, p. 254; Tert. Vert., p. 651.

is from the Wahsatch of New Mexico. It is about the size of the larger specimens of *H. index*. The first lower premolar is single rooted, and separated by a considerable diastema from the second. The third premolar has a very small second anterior cusp, and the fourth cusp on the last or fourth premolar is rather distinct. (Nos. 157*a*, 165, 4582 and 4603 of the Am. Museum collections.) One specimen in the collection (No. 165) shows a very decided variation, upon which I hesitate to propose a new species. The diastema between the first and second lower premolars is practically absent, and there is a well-developed second anterior cusp upon the third lower premolar. The first premolar is one-rooted, and the fourth has a very small fourth cusp. Several other species have been referred here by Cope, notably *P. loevi* and *P. cinctus*. The former of these I regard as a small variety of *cristonense*, and the latter I consider to belong to *Orohippus*, since it is from the Bridger formation.

**Hyracotherium (Pliolophus) montanum,** sp. nov.

I propose this species upon two fragments of lower jaws (No. 4593) of the same individual. The distinguishing character of this species is (1) the absence of any diastema between the first and second premolars, and (2) the two-rooted condition of the

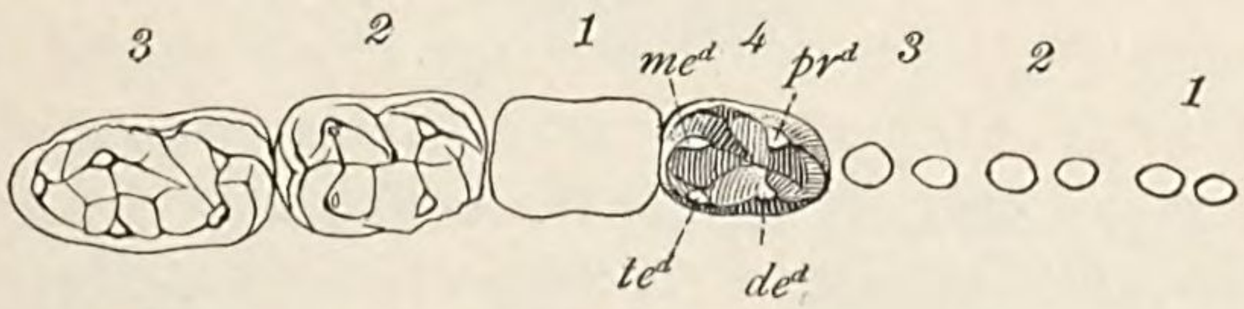



Fig. 13. *Hyracotherium (Pliolophus) montanum.* Lower teeth, crown view (type specimen, No. 4593). Wahsatch Beds, Big Horn. X ⅓.

first premolar. In the specimen here described the crowns of the three anterior premolars are not preserved, but the roots indicate the characters mentioned above. The fourth premolar displays a small but distinct fourth cusp. The last two molars which are preserved exhibit the same structure as those in *H. index*, with the larger of which the present specimen agrees in size.

## **Protorohippus,** gen. nov.

I come lastly to consider the Wind River representative of the horse family, which led directly up to the later Bridger form *Orohippus* (*Pachynolophus*). The *generic characters* have already been referred to above, but may now be more definitely stated as follows: No vestige of the fifth digit in the hind foot. Superior molars with subcrescentic external cusps, and having frequently small but distinct rudiments of mesostyle and hypostyle. Fourth superior premolar with only three principal cusps, the fourth (antero-internal in this case) small and more or less in the position of an intermediate. Third superior premolar with four principal cusps, the antero-internal considerably enlarged and shifted inwards to form a cusp analogous with the protocone of the true molars.

By giving to this form a separate generic name we have a distinct genus for each of the groups of species in the four great divisions of the Eocene, as represented in this country, viz.: *Hyracotherium* in the Wahsatch, *Protorohippus* in the Wind River, *Orohippus* in the Bridger, and *Epihippus* in the Uinta.

Of these, *Hyracotherium* is the oldest and clearly the most primitive; this is seen in the vestige of the fifth digit in the hind foot, the low conic form of the outer cusps of the superior molars, without any trace of the mesostyle or hypostyle, as well as the simple premolars. This is followed by *Protorohippus*, which has made a distinct advance in the loss of the vestige of the fifth digit in the hind foot, as well as the advance in the structure of both molars and premolars. *Orohippus* (*Pachynolophus*) continues the phylum into the Bridger, where the *third* and *fourth* premolars become fully molariform. This is again closely followed by *Epihippus* of the Uinta, in which the *second* superior premolar has assumed the molariform pattern, while from this latter genus to *Mesohippus* of the White River Miocene is but a short step, the only difference between the two which I am able to distinguish with certainty being the more perfectly molariform structure of the second superior premolar, and the reduction of the fifth digit of the *fore foot* to a vestige in the White River genus.

## Protorohippus venticolus (*Cope*).

The type of this species is the more or less perfect skeleton described by Cope as *Hyracotherium venticolum* (No. 4832). The specific characters have been so fully stated by this author that I am unable to add anything to his original description. The

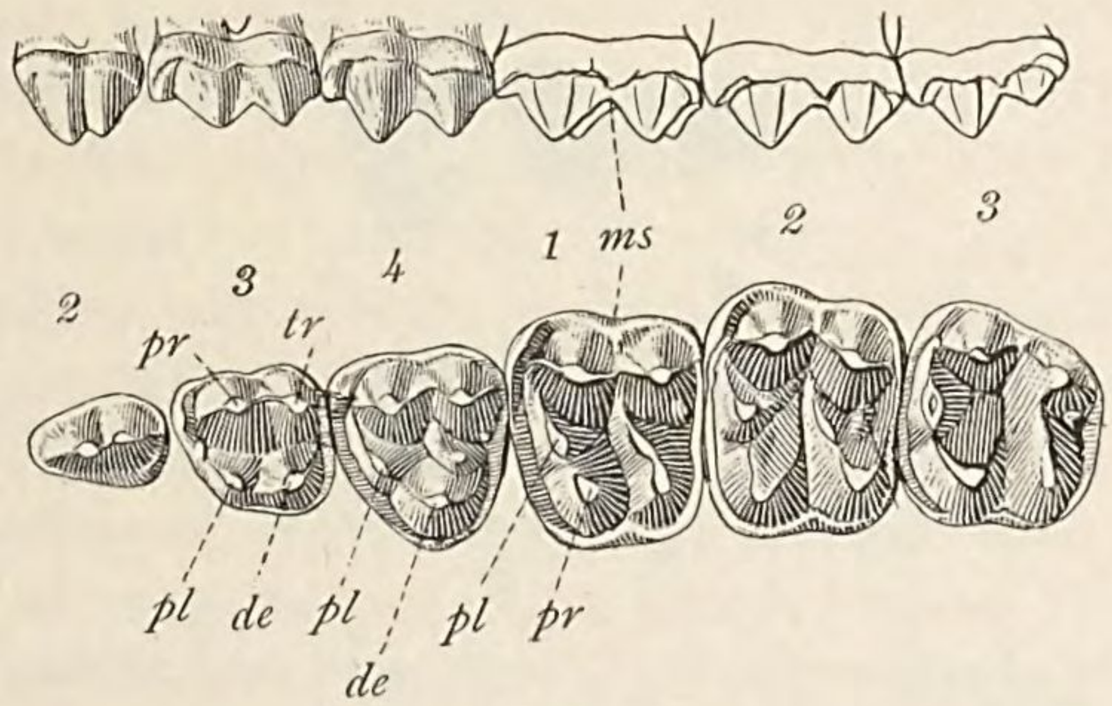



Fig. 14.

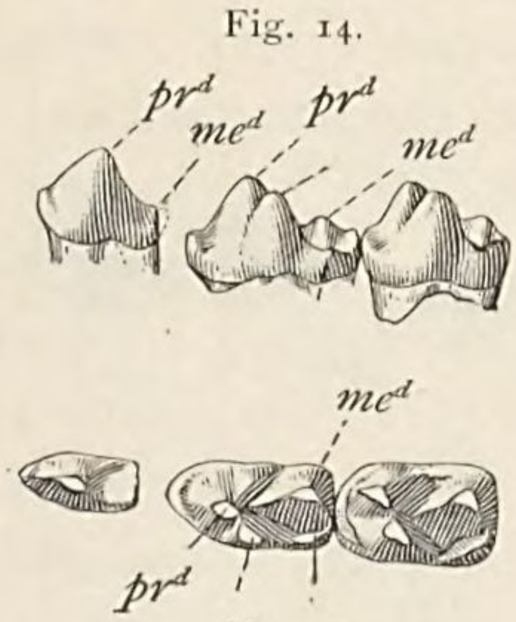



Fig. 15.

Figs. 14 and 15. *Protorohippus venticolus.*

Fig. 14. Upper teeth, side and crown views (composition from Nos. 4839 and 4832). Wind River Beds. × $\frac{4}{3}$.

Fig. 15. Lower premolars, side and crown views (No. 4834). Wind River Beds. × $\frac{4}{3}$.

teeth of the type specimen are badly worn, and without additional material it would have been impossible to make out those important characters of the teeth, which in my judgment take it out of the genus *Hyracotherium*. A number of smaller specimens from the Wind River Beds (Nos. 4833–41) display the same characters as the type of the genus, but I hesitate to group them into a distinct species until more is known of them.

PRINCIPLES OF PREMOLAR EVOLUTION IN THE AMERICAN HORSES.

A scheme of nomenclature for the cusps of the premolars has been proposed by Prof. W. B. Scott[1] for all the mammalia, in which it is attempted to express the homologies of the several parts of the tooth crown in all forms. Owing to some differences in the order of appearance of the several cusps in the different

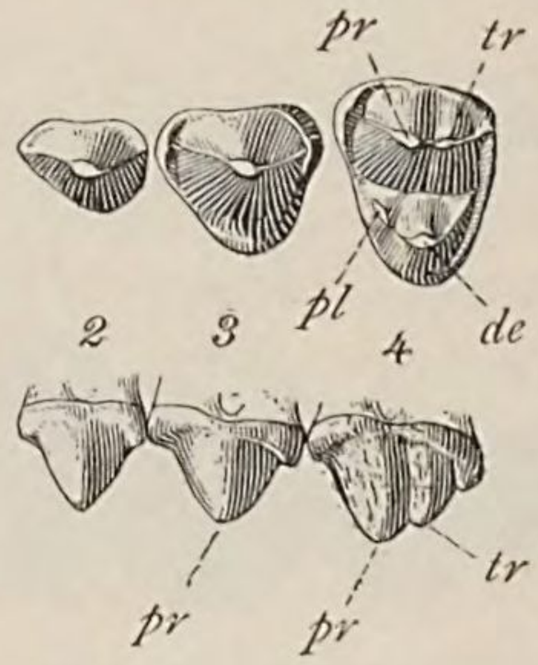



Fig. 16. *Euprotogonia puercensis.* Upper premolars, crown and side views (No. 3874). Puerco Beds of New Mexico. X $\frac{4}{3}$.

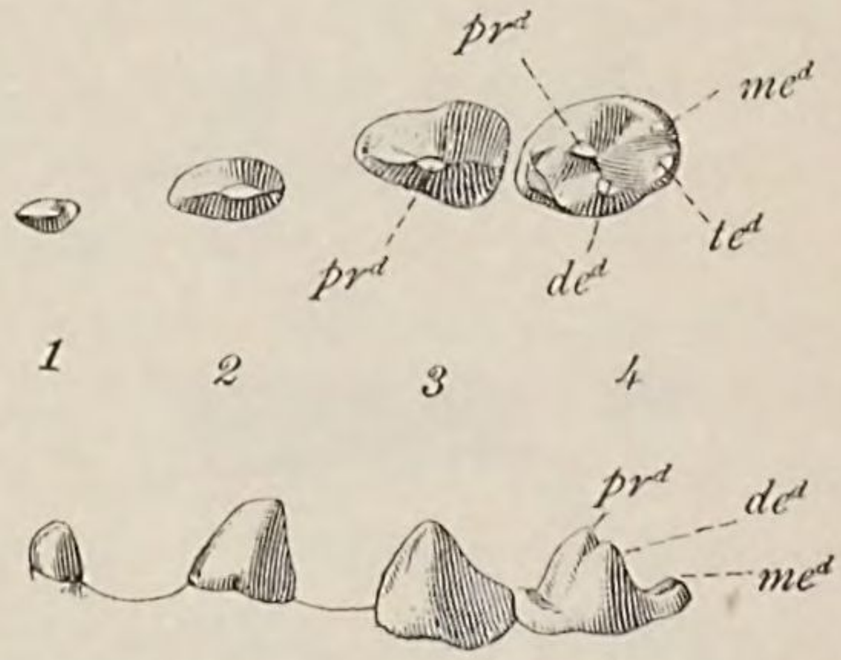



Fig. 17. *Euprotogonia plicifera.* Lower premolars, crown and side views (No. 4084). Puerco Beds of New Mexico. X $\frac{4}{3}$.

premolars, he selects the fourth as being constant in the manner in which the successive parts have been added. He says,[2] "so far as I have been able to observe, the scheme of development of the premolar crown is quite constant, and for superior premolar 4 universally so, and the nomenclature which is here

[1] Proc. Acad. Nat. Sci. Phila., 1892, p. 405.
[2] Loc. cit., p. 414.

proposed for the premolar cusps is intended to express their order of succession as they appear in this tooth."

The crown of the premolar in either jaw in its most primitive stage, consists of a single cone implanted by a single root; to this is added a second cusp, sometimes, as in the *superior series* of *Euprotogonia*, to the *inner* or lingual side of the primitive cone, and sometimes, as in *Hyracotherium index* and *Systemodon primævus*, immediately *posterior* to the primitive cone. The third element always makes its appearance either as this posterior cusp just mentioned (*Euprotogonia*), or as the internal cusp (*Hyracotherium*). In this stage of development we have therefore a three-cusped tooth with a triangular crown.

The primitive cone always occupies the same position, viz.: at the antero-external angle of the crown, and is known as the *protocone*. The cusp which is added to the lingual side of this cusp, irrespective of whether it appears previous to or subsequent to the posterior cusp, is given by Scott the name of *deuterocone*. In like manner the third cusp is called the *tritocone*.

In regard to the further complication of the tooth crown by which the tooth passes from a tritubercular to a quadritubercular stage, Prof. Scott further says: "The final step in the conversion of the premolar to the molar pattern is given by the addition of a fourth main element at the postero-internal angle of the crown, the *tetartocone*, which corresponds in position to the hypocone of the molars." Examples of this addition are to be seen in many forms, and it has undoubtedly been the usual method in the evolution of these teeth.

In the horse series of America, however, the addition of this fourth main element to the crowns of the superior premolars has pursued an entirely different course, and instead of appearing at the postero-internal angle of the crown, *it has been added at the antero-internal angle*. The proof of this assertion is to be found in the third and fourth superior premolars of *Hyracotherium index* and *Protorohippus venticolus*.

In the former of these species the crown of the fourth premolar is made up of two strong subequal more or less conic external cusps, together with a large simple median more or less lunate internal cusp. A little anterior and internal to this cusp, as if it

were a slightly constricted off part of the large crescentic internal, is a small cusp, occupying the position of an intermediate or protoconule. In the third premolar this same cusp is to be seen, but it is stronger and has a more forward position, giving to the crown a more quadrangular outline.

In *Protorohippus venticolus* this cusp in the crown of the third premolar is decidedly stronger, and has such a forward and internal or lingual position as to give to the crown quite a quadritubercular appearance. In the fourth premolar the position of this cusp is more nearly as it is in the third premolar of *H. index*, and the crown has not made as rapid progress towards the quadritubercular condition as the third. It has, however, made considerable advance in the direction of the formation of the antero-internal cusp, as is seen in the more forward and inward position of the element which is destined to become the fourth tubercle.

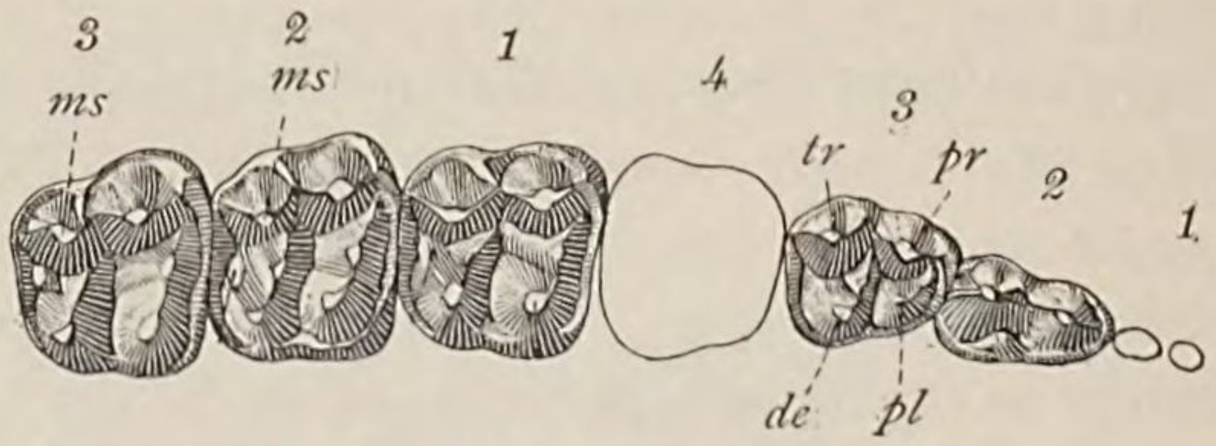



Fig. 18. *Orohippus*. sp. Upper teeth, crown view (composition from Nos. 1735, 1737 and 1738). Bridger Beds, Wyoming. X $\frac{4}{3}$.

In the Bridger species of *Orohippus* a still further advance is made, and both third and fourth premolars have become almost fully molariform or quadritubercular by the still greater enlargement and growing inwards of this cusp under consideration.

It is thus demonstrated, I hold, that the antero-internal cusp in these premolars was the last of the principal elements added, and while it is analogous, so far as the date of its appearance is concerned, with the *tetartocone* in other forms, it is not homologous with the cusp so named, either in position or in origin.

Another fact of much interest in this connection is the practical assumption of the molariform structure of the third superior premolar in advance of the fourth in the American Horses. This is apparently not true of the European species, if one can place any

dependence upon the drawings of Kowalewsky and Rütimeyer, nor, on the other hand, is it true that the antero-internal cusp was the last one to be added to complete the quadritubercular crown in the European species, as I have attempted to show above is true of the American species. Upon this ground I hold that the Lower Eocene European and American Horses probably represent entirely distinct phyla, having in all probability a common beginning in the least modified species of the genus *Hyracotherium*.

## EXPLANATION OF PLATE II.

### Upper and Lower Teeth of Eocene Horses.

*A—E.* Upper teeth. All natural size.

*A.* *Euprotogonia puercensis*, No. 3874, Puerco Beds, New Mexico.

*B.* *Hyracotherium tapirinum*, Nos. 139, 212, Wahsatch Beds, Big Horn.

*C.* " *index*, No. 4602, Wahsatch Beds, Big Horn.

*D.* *Protorohippus venticolus*, Nos. 4839, 4832, Wind River Beds.

*E.* *Orohippus* sp., Nos. 1735, 1737 and 1738, Bridger Beds.

*F—N.* Lower teeth. All natural size.

*F.* *Euprotogonia plicifera*, No. 4084, Puerco Beds, New Mexico.

*G.* *Hyracotherium vasacciense*, No. 4659, Wahsatch Beds, Big Horn.

*H.* " *cristatum*, Nos. 240, 258*b*, " " "

*I.* " (*Pliolophus*) *cristonense*, No. 165, Wahsatch Beds, Big Horn.

*I'.* " " " (No. 1002, Nat. Mus. Coll.), Wahsatch Beds, New Mexico.

*J.* " " *montanum*, No. 4593, Wahsatch Beds, Big Horn.

*K.* " *tapirinum*, Nos. 143*a*, 4657, Wahsatch Beds, Big Horn.

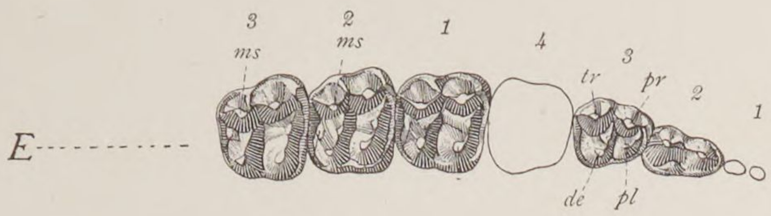
*L.* " *index*, No. 4613, Wahsatch Beds, Big Horn.

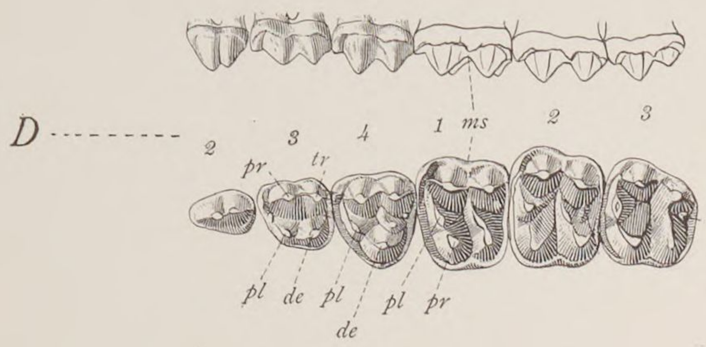
*M.* " *craspedotum*, No. 4830, Wind River Beds.

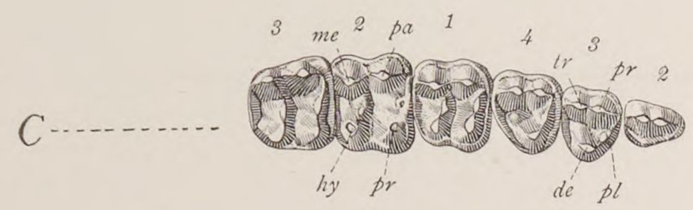
*N.* *Protorohippus venticolus*, No. 4834, " " "

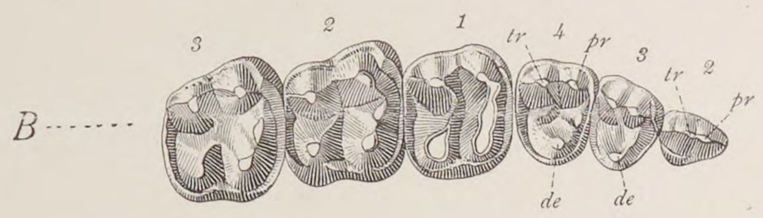
---

Abbreviations: *pr.*=protocone, *me.*=metacone, *pa.*=paracone, *de.*=deuterocone, *tr.*=tritocone, *hy.*=hypocone, *pl.*=protoconule, *ms.*=metastyle, *prd.*=protoconid, *pad.*=paraconid, $me^{d.}$=metaconid, $hy^{d.}$=hypoconid, *ded.*=deuteroconid, $te^{d.}$=tetartoconid, $ps^{d}$=parastylid, $hl^{d.}$=hypoconulid.



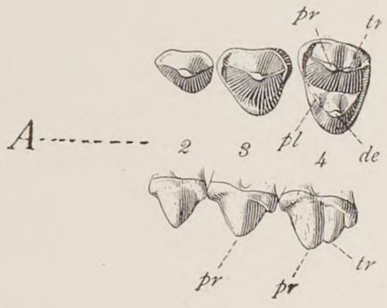



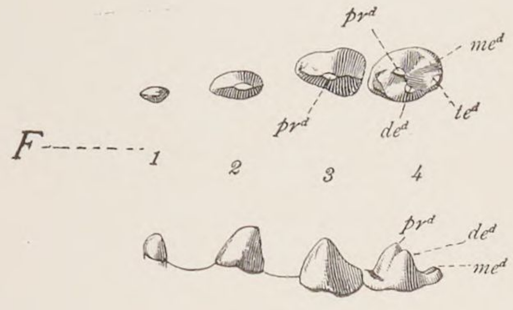



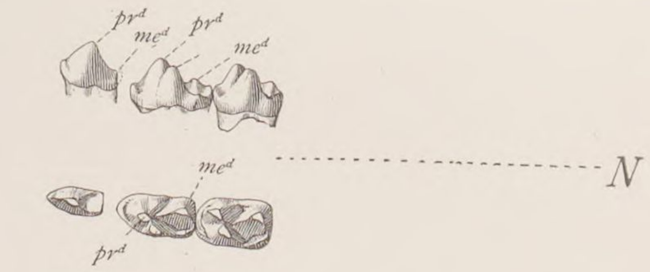



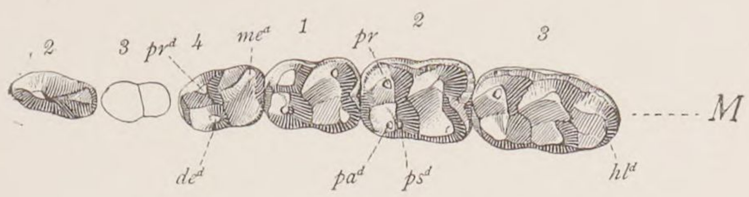


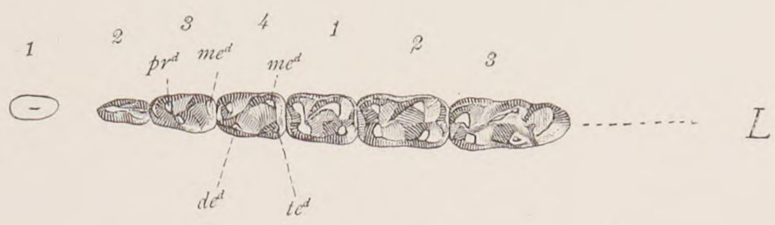


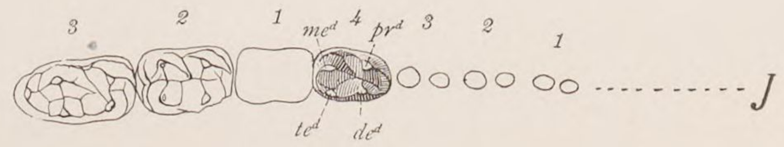


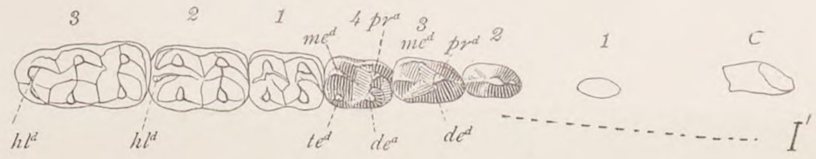



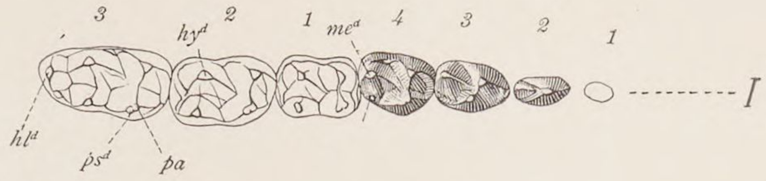



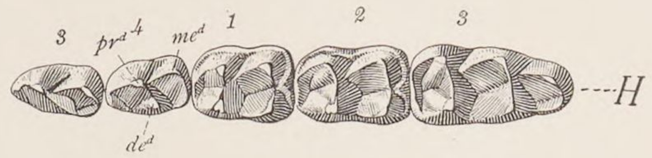



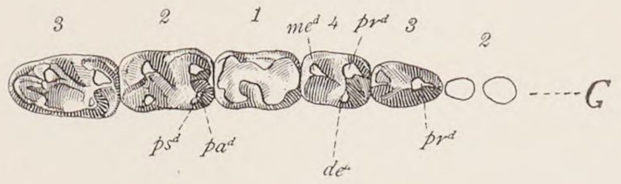




UPPER AND LOWER TEETH OF EOCENE HORSES.

Natural Size.

# Article VII.—CRITICAL REVIEW OF THE SESIIDÆ FOUND IN AMERICA, NORTH OF MEXICO.

By William Beutenmüller.

The Clear-winged Moths or Sesiidæ (*Ægeriidæ*) may be superficially recognized by their narrow and more or less transparent wings, by the filiform or clavate antennæ being either ciliate, pectinate or simple ; also by the tuft at the end of the body which they can spread like a fan, especially in the male. They fly rather swiftly in the hottest sunshine, and may be readily mistaken for wasps and flies, which they resemble in appearance. On the whole the specific and generic differences of the Sesiidæ are very slight, though constant in most cases, but it requires considerable attention and careful comparison of specimens to distinguish one from another. In some species the males differ from the females, and in many instances the male has been described under one name and the female of the same species under another, or individuals more or less worn through age and flight have been described and named as different species, thus creating considerable confusion in the study of this group of Moths and in our lists. It has, therefore, seemed to me advisable for the present to consider the species only, leaving the generic value of some of the groups here recognized as genera for future consideration, and until more material has been obtained.

My studies of the Sesiidæ have been mainly based upon the types and material in the Hy. Edwards Collection in the American Museum of Natural History.

I am also under obligation to many friends and correspondents for generous aid, otherwise this paper could not have been prepared.

To Mr. G. F. Hampson, of the British Museum, I am indebted for notes and colored sketches of Walker's types.

I am also indebted to Mr. L. O. Howard for the loan of types and specimens from the U. S. National Museum Collection, and

to Prof. W. B. Barrows (through Mr. G. C. Davis) for loan of types in the Tepper Collection in the Agricultural College of Michigan.

To Mr. S. Henshaw for material from the Museum of Comparative Zoölogy at Cambridge, Mass., and for notes on Harris's types in the Boston Society of Natural History; to Prof. J. H. Comstock for loan of material from the Cornell University Collection at Ithaca, N. Y.; to Mr. J. Doll for allowing me to examine the types in the Neumoegen Collection.

For notes and specimens I am also under obligation to the following entomologists: Prof. Otto Lugger, St. Anthony Park, Minn.; Prof. D. S. Kellicott, Columbus, Ohio; Prof. F. H. Hillman, Reno, Nevada; Dr. H. H. Behr, San Francisco, Cal.; Prof. A. D. Hopkins, Blackburg, W. Va.; Messrs. Chas. Palm, L. H. Joutel, H. G. Dyar, and Mrs. A. T. Slosson, New York; J. L. Zabriskie, Brooklyn; Prof. A. R. Grote, Bremen, Germany; F. W. Kirby of the British Museum, and for many favors to Mr. Wm. Schaus.

With the aid of the types and material which have been submitted to me for examination I have been enabled to recognize all the known species of Sesiidæ found in America, north of Mexico, except the following: *Albuna modesta* Kellicott and *Melittia snowii*, which I have not had the opportunity to examine. The following species, described by Boisduval, are also unknown to me, viz.: *Sesia anthraciformis*, *S. bibionipennis*, *S. nomadæpennis*, *S. chrysidipennis* and *S. xiphiæformis*. Prof. A. R. Grote and myself are of the opinion that the latter species is the same as the female of *Sanninoidea exitiosa*.

In previous papers I have used the term Ægeriidæ instead of Sesiidæ. This latter term has precedence, and must be used. The type of the genus *Sesia* is, so far as we can ascertain, *culiciformis*, it having been restricted to this species by Hübner (Tentamen, 1806).

As stated in the Museum Bulletin, Vol. VI, p. 87, a monograph of the Sesiidæ inhabiting North America is in course of preparation, and material from all parts of the world would be greatly appreciated; also local lists, notes on the life histories, habits, etc., of the American species, even of the most common, would be gratefully received.

As the specimens of this family soon become abraded through flight and discolored through age, perfect examples are required for description and figuring, especially as to their coloration, and specimens sent to me for this purpose would be safely returned if desired.

## Melittia curcurbitæ (*Harris*).

*Ægeria curcurbitæ* HARRIS, New England Farmer, Vol. VIII, 1828, p. 33.
*Trochilium ceto* WESTWOOD, Orient. Cab. Ent. 1848, pl. 30, fig. 6.

This well-known species was described by Harris as *Ægeria curcurbitæ*, and later by Westwood as *Trochilium ceto*; consequently the former name must be used. Doubleday (Harris's Corresp., 1869, p. 161) states that *Ægeria curcurbitæ* is *Melittia satyriniformis* Hübner, and if so this latter name would have precedence. Mr. Samuel Henshaw kindly examined for me Hübner's work (Zuträge Exot. Schmett., 1825), in the library of Harvard University, and writes me as follows: "The figure of *Melittia satyriniformis* differs from all *curcurbitæ* that I have seen, in coloration; the abdomen is dark blue black with light blue margins to each segment and without a trace of the orange so conspicuous in *curcurbitæ*."

*Habitat:* Canada, United States, Central and South America.

The larva lives in the stems of the cucumber and other allied plants.

## Melittia amœna *Hy. Edw.*

*Melittia amœna* HY. EDWARDS, Papilio, Vol. II, 1882, p. 53.

Not known to me. It was described from a single male, and the type is said to be in the collection of Prof. Snow. Hy. Edwards describes it as follows:

"Head black in front, with a few bluish scales. Palpi above orange, beneath white, terminal joint black within. Eyes dull orange, with the orbits clear white. Antennæ bluish black. Thorax dull bronze black, with the collar pale dull greenish, and the long hairs on the sides sordid white, with dull greenish reflection. Abdomen black, with purplish reflection; posterior edges of the segments narrowly greenish white. Caudal tuft orange brown, with black hairs. Bands on the lower side of abdomen a little wider than above. Fore coxæ black, with orange scales. Middle and hind coxæ black, edged with whitish. Fore and middle tibiæ rich orange exteriorly; black within. Bunch of hairs on hind

tibiæ rich orange, with a few white hairs intermixed ; black within. All the tarsi are black. Fore wings purplish black, covered with bright metallic green scales, less visible below. Fringes of both wings brownish black. Expanse, 27 mm. *Habitat :* Kansas."

## Melittia snowii *Hy. Edw.*

*Melittia snowii* Hy. Edwards, Papilio, Vol. II, 1882, p. 53.

Allied to *M. curcurbitæ.* The fore wings are pale grayish brown, without any metallic green lustre. The hind tibiæ are also pale grayish brown, and the tarsi clothed with black hairs within. Palpi white. Expanse, 22 mm.

*Habitat :* Kansas.

## Melittia gloriosa *Hy. Edw.*

*Melittia gloriosa* Hy. Edwards, Bull. Brooklyn Ent. Soc. Vol. III, 1880, p. 71.

This beautiful species may be known by its large size and robust form.

The fore wings are light grayish brown with a slight orange tint. The hind wings in the male are transparent, with the veins and inner margin heavily marked with bright orange ; hind wings of the female entirely covered with orange scales. Thorax grayish brown. The abdomen has the top of the first, second and fourth segments grayish brown ; third and fifth segments yellow ; sides orange ; last two segments grayish brown, with a decided metallic light blue reflection ; the extreme posterior edge of each segment is scaled with light blue ; hind tibiæ and tarsi with long orange hairs ; black outside and straw yellow at base of tibiæ. The antennæ of the male are strongly bipectinate. Expanse, 41 mm.

*Habitat:* California.

The insect was reared by F. E. Blasedale from the roots of *Rhus laurina* (Proc. Ent. Soc. Wash., Vol. I, p. 85). Dr. H. H. Behr writes me that the larva feeds in the herbaceous climbing stems of *Megarrhiza.*

## Melittia grandis (*Strecker*).

*Trochilium grandis* Strecker, Can. Ent. Vol. XIII, 1881, p. 156.

Closely allied to *M. gloriosa*, but it is quite distinct. The fore wings are similar in color to *gloriosa.* The hind wings in both sexes are transparent. The abdomen is brown dorsally and

orange laterally, with the posterior edges of each segment very narrowly scaled with pale grayish brown. The underside of the abdomen is pale orange, while in *gloriosa* it is whitish. The pectinations of the antennæ of the male are also not as long as in *gloriosa*. Expanse, ♂, 38; ♀, 45 mm.

*Habitat:* Arizona and Texas.

### Gaëa (gen. nov.) solituda (*Hy. Edw.*).

*Larunda solituda* Hy. Edwards, Papilio, Vol. I, 1881, p. 182.

The wings of this insect are dirty brown, streaked with dull orange and yellow in the cell of the fore wings and in the area beyond the discal mark. The hind wings are transparent at the extreme base, and marked beyond with dull orange between the veins. The abdomen has a yellow band on each segment. The antennæ of the male are rather strongly pectinated, simple in the female. Expanse, 31 mm.

*Habitat:* Kansas and Texas.

The name *Larunda*, given by Hy. Edwards to this species, was previously established by Hübner (Verzeich. bek. Schmett., 1816, p. 289) for a genus in the Geometridæ, and therefore must be changed. I propose the name *Gaëa* instead, with *L. solituda* Hy. Edw. as the type.

### Gaëa emphytiformis (*Walker*).

*Ægeria emphytiformis* Walker, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 43.
*Bembecia emphytiformis* Grote, Check List N. Am. Moths, 1882, p. 11; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 23.

A type female of Walker's *Ægeria* (*Bembecia*) *emphytiformis* from the British Museum is before me. It is not a *Bembecia*, but is congeneric with *Gaëa solituda*, to which it is allied, but is much smaller. The fore wings are purplish brown with slight traces of a few reddish streaks in the area beyond the discal mark. Hind wing also purplish brown, transparent at the base, orange at base of inner margin. In *solituda* the spaces between the veins are heavily marked with dull orange yellow. Expanse, 20 mm.

*Habitat:* United States (Walker). The definite locality is not known.

## Euhagena nebraskæ *Hy. Edw.*

*Euhagena nebraskæ* Hy. Edwards, Papilio, Vol. I, 1881, p. 180.
*Pyrrhotænia coloradensis* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 25.

A very remarkable form, differing greatly from any other species known to me. I have examined the type in the Cambridge Museum, and find that the insect I described as *Pyrrhotænia coloradensis* to be the same. Mr. L. O. Howard kindly sent me for study a perfect male from the collection of the U. S. National Museum.

The antennæ are thick with rather long, closely applied pectinations which extend to a little before the tip. The palpi are erect and clothed with loose, long hairs, as are also the head and collar. The wings are opaque, red, with a rather broad discal bar. The margins of the wings are black with the fringes fuscous. Over the outer portion, the hind wings are thinly scaled with black. Thorax black with some silvery white hairs. The hairs on the head, collar and palpi are also mixed with white. Abdomen black with a silvery white scale-like band on each segment; femora and tibiæ with short loose hairs. Anal tuft black. Expanse, 18–22 mm.

*Habitat:* Colorado and Nebraska.

## Alcathoë caudatum (*Harr.*).

*Ægeria caudata* Harris, Am. Journ. Sc. and Arts, Vol. XXXVI, 1838, p. 311; Walker, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 42; Packard, Guide Study Insects, 1869, p. 278; Martin, 5th Rep. Nox. Ins. Illinois, 1881, p. 108.
*Trochilium caudatum* Fitch, Nox. Ins. N. Y. 1856, p. 424; Morris, Synop. Lepid. N. Am. 1862, p. 139; Bethune, Can. Ent. Vol. I, p. 18; Hy. Edwards, Papilio, Vol. II, 1882, p. 53.
*Sesia caudata* Boisduval, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 437.
*Alcathoë caudatum* Hy. Edwards, Papilio, Vol. II, 1882, p. 53; Smith, Ent. Am. Vol. IV, 1888, p. 11; Cat. Ins. N. J. 1890, p. 288; Beutenmüller, Cat. Lepid. N. Y. 1890, p. 204; Kellicott, Can. Ent. Vol. XXIV, 1892, p. 44.
*Alcathoë caudata* Jack, Garden and Forest, 1891, p. 496. (Larva and pupa.)

*Male.*—Fore wings transparent from the base to the middle, with the costal and inner margins and outer half purplish brown with a purplish reflection; hind wings transparent, bordered with purplish black; legs orange, hind tibiæ clothed with black hairs; abdomen with a long orange anal tail-like appendage, and a short black pencil on each side at the base; antennæ orange.

*Female.*—Fore wings entirely purplish brown; legs black, tarsi orange. Abdomen in both sexes black. Expanse, 20–32 mm.

*Habitat:* Canada, Michigan, Illinois, New York, south to Virginia.

The legs of the insect are subject to variation, being marked more or less with black. The form with entirely black legs and antennæ has been named *walkeri* by Mr. Neumoegen.

Harris states that the larva inhabits the stems of our indigenous currant (*Ribes floridum*). Mr. Jack in 'Garden and Forest,' 1891, p. 496, gives a good account and figure of the larva and habits. He states that it bores in the roots of *Clematis*. Mr. Joutel and myself have also raised the species from this plant. Harris's observation is certainly founded upon an error. Mr. J. Doll has also raised the insect from the roots of *Clematis*.

## Sannina uroceriformis *Walker*.

*Sannina uroceriformis* WALKER, Cat. Lep. Brit. Mus. pt. VIII, 1856, p. 64; MORRIS, Synop. Lepid. N. Am. 1862, p. 334 (quotes Walker); BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 24.
*Saunina uroceripennis* BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 465; HY. EDWARDS, Ent. Amer. Vol. III, 1888.
*Ægeria ? quinquecaudata* RIDINGS, Proc. Ent. Soc. Phil. Vol. I, 1862, p. 277; PACKARD, Guide to Study of Insects, 1869, p. 279.
*Sospita quinquecaudata* HY. EDWARDS, Papilio, Vol. II, 1882, p. 56.
*Phemonoë quinquecaudata* HY. EDWARDS, Papilio, Vol. II, 1882, p. 97; RILEY, Proc. Ent. Soc. Wash. Vol. I, 1888, p. 85; Insect Life, Vol. IV, 1892, p. 332.

A colored figure of the type of this species in the British Museum was kindly sent to me by Mr. G. F. Hampson, and it is without doubt the female of *Phemonoë quinquecaudata* Ridings. The example regarded by Walker as the female is probably the female of *S. exitiosa*. Boisduval changed the name to *Saunina uroceripennis* in order to avoid confusion with the Europeon *Sesia uroceriformis*. The change, however, was superfluous, as our species is generically distinct from the European.

The insect is wholly blue black, with an orange band on the fourth segment above; sometimes in the male the fourth, fifth and sixth segments are orange yellow above. The hind wings are transparent at the extreme base. The male has five tufts at the end of the body. Expanse, 30–33 mm.

*Habitat:* Virginia to Florida; Montana.

The larva lives in the roots of Persimmon.

## Trochilium pacificum *Hy. Edw.*

*Trochilium pacificum* HY. EDWARDS, Papilio, Vol. I, 1881, p. 180.
*Trochilium californicum* NEUMOEGEN, Ent. News, Vol. II, 1891, p. 108.

In the Museum Bulletin, Vol. VI, p. 365, I proposed to unite *Trochilium californicum* with *T. pacificum.* Since then I have examined the type of *californicum* in the Neumoegen Collection, and find that my conclusion was correct. The larva bores in the Cottonwood.

*Habitat:* Nevada, Montana, California and Washington.

## Trochilium tibiale *Harris.*

*Trochilium tibiale* HARRIS, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 309.
*Trochilium minimum* NEUMOEGEN, Ent. News, Vol. II, 1891, p. 108.

The type of *T. minimum* Neum. was examined by me, and it is the same as *T. tibiale.* This verifies my conclusion of uniting the two species as mentioned in the Museum Bulletin, Vol. VI, p. 366. The larva inhabits the Poplar and Willow.

*Habitat:* New York, Canada, New Hampshire, Massachusetts, Colorado, California and Vancouver Island.

## Trochilium apiforme (*Linn.*).

This well-known European species is found in this country as far west as Nevada. It inhabits the roots and lower parts of the trunks of Poplar and Willow. The insect is said to be very sluggish in habit, and to be readily picked off the trees when resting.

## Bembecia marginata (*Harris*).

The type of *Bembecia pleciæformis* Walker in the British Museum was kindly examined for me by Mr. G. F. Hampson, and his note is as follows: "The type of *Bembecia pleciæformis* is a male in bad condition, but without the least doubt it is the same as *B. marginata.* The markings are exact, as are the metallic blue pectinated antennæ; the partial obsolescence of the yellow

bands on the thorax and abdomen is due to grease, but they are traceable." The synonymy[1] of the species now stands as follows:

BEMBECIA MARGINATA *Harris.*
" *pleciæformis* WALKER.
" *odyneripennis* WALKER.
" *rubi* RILEY.
" *flavipes* HULST.

*Habitat:* Canada, westward to Gulf of Georgia; Atlantic States, Ohio and Missouri.

The insect in its larval state lives in the roots and canes of Blackberry and Raspberry. The female moth is sluggish in habit, and drops to the ground when touched. The male, however, is very active. The variety *albicoma* has white bands on the abdomen instead of yellow, as in the type form.

## Vespamima sequoiæ (*Hy. Edw.*).

*Bembecia sequoiæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 181.
*Vespamima sequoiæ* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 87.

This species was described as a *Bembecia*, but was placed in a new genus (*Vespamima*) by me. It is distinct from *Bembecia*, differing by having much longer antennæ, which are ciliate in the male instead of with long pectinations as in *Bembecia*. It also differs in shape and venation. The larva is destructive to *Sequoia sempervirens*, *Pinus ponderosa* and *Pinus lambertiana* in California. *Bembecia superba* was placed by me as a synonym of *V. sequoiæ* (Bull. A. M. N. H., Vol. VI, p. 87).

## Sciapteron denotata (*Hy. Edw.*).

*Albuna denotata* HY. EDWARDS, Papilio, Vol. II, 1882, p. 55.
*Sciapteron denotata* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 24.

Originally described as an *Albuna*, but placed by me in the genus *Sciapteron*. It is closely related to the European *S. tabaniformis*, but is a much smaller insect, and differs in the number of bands on the abdomen in the female.

[1] See Bull. Am. Mus. Nat. Hist., Vol. V, 1893, p. 22.

Fore wings sooty black with a strong violet reflection ; along the inner margin lined with rufous ; at the insertion of the fore wings is a yellow spot. Collar yellow ; palpi black, tips yellow. Abdomen black with a yellow ring on the second, fourth and last two segments in the male. In the female there are five bands on the abdomen. Antennæ violet black above, rufous beneath, bipectinate in the male, simple in the female. Coxa yellow, femora black, middle femora with an orange band ; hind femora orange, black at base ; all the tarsi orange. Expanse, 27 mm.

*Habitat :* New Hampshire, westward to Montana.

## Sciapteron tricincta (*Harr.*).

*Ægeria tricincta* HARRIS, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 310.
*Sciapteron tricincta* HY. EDWARDS, Grote, New Check List of Moths, 1882, p. 12.

Closely allied to *denotata*, but differs by having three broad bands on the abdomen in the male and four in the female. The species was reared by Prof. D. S. Kellicott from enlargements of the branches and stems of Poplar (*Populus candicans*) and Willow (*Salix*), caused by the larva of *Saperda concolor* and *S. moësta*.

*Habitat :* Canada, Massachusetts, New York, Ohio, Pennsylvania and Michigan.

## Sciapteron robiniæ *Hy. Edw.*

*Sciapteron robiniæ* HY. EDWARDS, Bull. Brooklyn Ent. Soc. Vol. III, 1880, p. 72.

This insect was described as having the thorax brown on the disc, yellow in front and behind. The types, which are before me, have the scales on the thorax abraded. A fresh example from the collection of the Museum of Comparative Zoölogy may be described as follows :

The thorax is deep black, with the patagia tipped with yellow at the posterior edge, and a transverse curved streak across the hind part of the thorax. Collar black, edged with yellow behind. Fore wings orange brown, veins somewhat darker. Hind wings transparent. Abdomen with first three segments above and below deep black, and not blackish brown, as in the original description. The second segment with a narrow yellow band, and the third segment with only a very slight trace of a band at the posterior edge ; remaining segments wholly yellow. Expanse, 25–35 mm.

*Habitat:* Nevada, California and Washington.

According to the late Hy. Edwards this species is destructive to *Robinia pseudacacia* and *Populus alba.*

## Sciapteron cupressi *Hy. Edw.*

*Sciapteron cupressi* HY. EDWARDS, Papilio, Vol. I, 1881, p. 183.

Only known by a single type in the Neumoegen Collection, which I have examined. It is a female, and not a male as described by Mr. Edwards. It differs from *S. robiniæ*, to which it is closely allied, if not identical, by having only the first segment black and the second and third segments marked with orange, while the remaining segments are wholly yellow. Expanse, 30 mm.

*Habitat:* Colorado.

## Sciapteron scepsiformis *Hy. Edw.*

*Sciapteron scepsiformis* HY. EDWARDS, Papilio, Vol. I, 1881, p. 183.

Fore wings deep blackish brown; hind wings transparent, with the outer border running some distance inward between the veins. The abdomen is brown with a narrow yellow ring at the end of the second segment. Expanse, 26 mm.

*Habitat:* Maryland, Kansas and Texas.

The male and food habits are unknown.

## Sciapteron simulans *Grote.*

*Trochilium* (*Sciapteron*) *simulans* GROTE, Bull. U. S. Geol. Surv. Hayden, Vol. VI, 1881, p. 257; Bull. Brooklyn Ent. Soc. Vol. III, 1881, p. 78.
*Trochilium luggeri* HY. EDWARDS, Psyche, Vol. VI, 1891, p. 108, pl. fig. 3; Bull. 43, Minnesota Agricul. Exp. St. p. 190, fig.
*Sciapteron simulans* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 366.

The type of *Trochilium luggeri* was kindly presented to me by Prof. Otto Lugger, and it is without doubt the same as *Sciapteron simulans* Grote, the type of which is also before me. Only the female is known. Prof. Lugger has bred the insect from Red-oak stumps.

*Habitat:* Rhode Island, Ohio, Illinois and Minnesota.

## Sciapteron palmii (*Hy. Edw.*).

*Fatua palmii* HY. EDWARDS, Can. Ent. Vol. XIX, 1887, p. 145.
*Sciapteron palmii* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 366.

This species is closely allied and congeneric with *S. simulans*. Only the female is known, and it is possible that a new genus will have to be erected for *palmii* and *simulans* when the males are known. The food habits are unknown.

*Habitat:* Florida.

## Sciapteron dollii *Neumoegen.*

*Sciapteron dollii* NEUMOEGEN, Ent. News, Vol. V, 1894, p. 330.

The late Hy. Edwards gave to this insect the name *Sciapteron castaneum*, the type of which is in the Neumoegen Collection. I am, however, unable to find a published description of this species anywhere in Mr. Edwards's papers, and conclude that it must be a MS. name. Two examples in the Edwards Collection are labeled *Trochilium polistiformis* Harris, and Mr. Edwards's note-book says "*Sciapteron castaneum=polistiformis.*" It therefore seems to me quite evident that before publishing *castaneum* he considered it the same as *polistiformis*, which is a different species. The larva lives in the trunk of young Poplar.

*Habitat:* New York, Kentucky and Texas.

## Sciapteron polistiformis (*Harris*).

*Ægeria polistiformis* HARRIS, Am. Pomol. Soc. 1854, p. 10; PACKARD, Guide Study Insects, 1869, p. 278; RILEY, 3d Rep. Nox. Ins. Mo. 1871, p. 75; MARTIN, 5th Rep. Nox. Ins. Ill. 1881, p. 108; SAUNDERS, Ins. Inj. Fruit, 1883, p. 229.
*Trochilium polistiformis* FITCH, 3d Rep. Nox. Ins. N. Y. 1856, p. 387.
*Sciapteron seminole* NEUMOEGEN, Ent. News, Vol. V, 1894, p. 330.

The types of Harris's *Ægeria polistiformis* are in the collection of the Boston Society of Natural History, and were kindly examined for me by Mr. Henshaw, who informs me that they agree very well with Riley's figures of the species (Third Rep. Nox. Ins.

Mo., p. 75). I have examined the type of *Sciapteron seminole* and find that this also agrees very well with Riley's figure and description of the female of *polistiformis*. I therefore propose to unite it with the latter species. The insect in its larval state burrows in the bark and sap-wood of the roots of both wild and cultivated Grape-vine.

*Habitat:* North Carolina, Florida, Missouri and Arizona.

## **Palmia** (gen. nov.) **præcedens** (*Hy. Edw.*).

*Sciapteron præcedens* Hy. Edwards, Papilio, Vol. III, 1883, p. 155.

Only known by a single specimen in the Neumoegen Collection. It is not a *Sciapteron*, but the type of a new genus. It differs from *Sciapteron* by having narrower wings with the apices very pointed and the outer margins more oblique. The palpi are much shorter, and not clothed with long hair-like scales as in *Sciapteron*. In *Sciapteron* the apices of the wings are rounded and the palpi more erect, reaching the vertex of the head, and are thickly clothed with long hair-like scales. The venation of *S. præcedens* is the same as in *Sciapteron*. The wings are brown, with a basal vitreous streak on the fore wings. The hind wings are vitreous at their base. Abdomen black, with the last three segments and anal tuft lemon yellow. The head is also smaller. Expanse, 30 mm.

*Habitat*: North Carolina.

I propose the name *Palmia* for this genus, with *S. præcedens* H. Edw. as type.

## Tirista admiranda (*Hy. Edw.*).

*Sciapteron admirandus* Hy. Edwards, Papilio, Vol. II, 1882, p. 54.
*Tirista admirandus* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 88.

This species has been placed by me in the genus *Tirista*. A figure of *Tirista argentifrons* was published by Mr. Druce in Biologia Centrali-Americana, Vol. I, Heterocera, Plate V, Figure 14, with which *admirandus* fairly well agrees generically. It differs from

*Sciapteron* by having plumose antennæ. Only a single specimen of this insect is known at present.

*Habitat:* Texas.

## Tarsa denudata (*Harr.*).

*Trochilium denudatum* HARRIS, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 310.
*Fatua denudata* HY. EDWARDS, Papilio, Vol. II, 1882, p. 97.
*Tarsa bombyciformis* WALKER, Cat. Lep. Br. Mus. pt. VIII, 1856, p. 61.
*Sesia asilipennis* BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. Vol. I, 1874, p. 91.
*Tarsa denudata* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 22.

Easily recognized by its large size. The male has the fore wings transparent, bordered with brown and an oblique brown cross-bar, centred with rufous, at the end of the cell. Abdomen with a narrow yellow band at the posterior end of each segment. The antennæ have very long pectinations. The female has the fore wings opaque, brown, a triangular transparent mark at the hind angle, and the antennæ simple. Expanse, 32–43 mm.

*Habitat:* New York, Massachusetts, New Jersey, District of Columbia, South Carolina, Georgia, Illinois, Michigan and Texas.

The larva lives in the roots and under the bark of Ash and Alder.

## Parharmonia pini (*Kellicott*).

*Ægeria pini* KELLICOTT, Can. Ent. Vol. XIII, 1881, pp. 5 and 158.
*Harmonia pini* HY. EDWARDS, Papilio, Vol. II, 1882, p. 54.

Fore wings black, with a metallic blue or green reflection. Hind wings thinly covered with black scales, transparent along the inner margin. Head, thorax and legs blue black. Collar orange. Abdomen above blue black, with an orange band on the fourth segment. Underside of abdomen wholly orange. Anal tuft orange, blue black in the middle above. Expanse, 28 mm.

*Habitat:* Canada and New York.

The larva lives under the bark of Pine.

## Parharmonia fraxini (*Hy. Edw.*).

*Carmenta fraxini* HY. EDWARDS, Papilio, Vol. I, 1881, p. 185.
*Harmonia morrisoni* HY. EDWARDS, Papilio, Vol. II, 1882, p. 54.
*Parharmonia fraxini* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 89.

Fore wings opaque, blackish brown with a violet reflection. At end of discal cell a red cross-bar. Hind wings transparent with a narrow violet black border. Body and legs black. Antennæ yellowish before the tip. Expanse, 21–25 mm.

*Habitat:* New York, New Jersey, Washington, D. C., Missouri and Montana.

## Parharmonia græfi (*Hy. Edw.*).

*Sciapteron græfi* Hy. Edwards, Papilio, Vol. I, 1881, p. 183.
*Parharmonia græfi* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 89.

Wholly black. Fore wings with a strong metallic green reflection like the female of *Sanninoidea opalescens*. Hind wings transparent with a narrow black border. Expanse, 27 mm.

*Habitat:* Nevada.

## Podosesia syringæ (*Harr.*).

Fore wings deep brown, with a slight violet lustre; at the base two short transparent streaks and marked with red on the costa and inner margin. Hind wings transparent, thinly scaled with brown outwardly; veins brown. Head brown, palpi and collar rufous; thorax brown, with the patagia tinged with rufous. Abdomen deep brown, with a yellow spot on each side of the fourth segment. Legs yellow, broadly banded with black; femora blackish. Expanse, 26–35 mm.

*Habitat:* Massachusetts, New York, westward to Iowa, and southward to Texas.

This is the well-known Lilac and Ash borer. It also affects the Mountain Ash (*Pyrus americana*), according to Prof. D. S. Kellicott.

## Podosesia fraxini (*Lugger*).

*Trochilium fraxini* Lugger, Psyche, Vol. VI, 1891, p. 109, pl. iii, fig. 4.
*Podosesia fraxini* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 88.

Closely allied to *P. syringæ*, but differs from it in having the fore wings testaceous, and the abdomen banded with yellow. The patagia are yellow at the posterior part, and the collar orange in front and yellow behind. Expanse, 27–34 mm.

*Habitat:* Minnesota and Montana.

The larva affects the Ash.

## **Sanninoidea** (gen. nov.) **exitiosa** (*Say*).

This species has been erroneously referred to the genus *Sannina*, the type of which is *S. uroceriformis* Walker (see *antea*, p. 117). *S. exitiosa* belongs to a different genus, for which I would propose the name *Sanninoidea*.

This is the well-known borer which is so injurious to the Peach.

The male has the wings transparent, with steel blue borders and fringes ; the borders are sometimes scaled more or less with yellow. Head black, with a yellow patch on the vertex ; palpi yellow below, black above ; collar black, yellow in the middle on top ; thorax black, with the patagia edged internally with yellow, this color forming an angle at the anterior portion of the thorax ; metathorax with a few yellow scale-like hairs. Abdomen blue black, narrowly banded with yellow on the second, fourth, fifth and sixth segments ; anal tuft wedge-shape, black, tipped with white laterally. Legs black, with joints yellow. The female is wholly steel blue black, with the fourth and sometimes also the fifth segment orange. Hind wings transparent, broadly bordered with blue black and scaled with this color at the base, and costa and also sometimes between veins one and two, thus leaving two small clear spaces. In the female variety *fitchii* Hy. Edw. all the segments from the fourth to the last, inclusive, are orange, and in the male variety *luminosa* Neum. the borders are heavily scaled with yellow. Expanse, 22–34 mm.

*Habitat:* Canada to Texas

## **Sanninoidea opalescens** (*Hy. Edw.*).

*Ægeria opalescens* Hy. Edwards, Papilio, Vol. I, 1881, p. 199.
*Sannina pacifica* Riley, Insect Life, Vol. III, 1891, p. 292.
*Sannina opalescens* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 366.

Allied to *S. exitiosa*. The male has the outer border of the fore wing twice as broad as in *exitiosa*, and the transverse bar at the end of the discal cell is also broader. The head, palpi, thorax and abdomen lack the yellow markings. The legs are black, with only a few whitish hairs on the tibiæ and tarsi. The female is like that of *exitiosa*, but all traces of the orange bands on the abdomen are wanting and the hind wings are transparent, with only a few steel blue scales basally and a narrow outer border. Expanse, 23–33 mm.

*Habitat:* Nevada, Colorado and California.

Like *exitiosa* this species also affects the Peach as well as the Apricot.

I have examined the types of *Sannina pacifica*, and have found that the male of this species was previously described as *Æ. opalescens*. I am indebted to Mr. L. O. Howard for the loan of one of the type females of *S. pacifica*.

## Albuna pyramidalis (*Walker*).

*Ægeria pyramidalis* WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 40; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. VI, 1894, p. 89.
*Ægeria hylotomiformis* WALKER, Cat. Lepid. Br. Mus. pl. VIII, 1856, p. 43.
*Albuna hylotomiformis* HY. EDWARDS, Papilio, Vol. I, 1881, p. 186.
*Albuna vancouverensis* HY. EDWARDS, Papilio, Vol. I, 1881, p. 188.

In the Museum Bulletin, Vol. V, 1893, p. 23, I published the following note made by the late Hy. Edwards on the type of Walker's *Æ. hylotomiformis:* "Is a good species, and is unknown to me." Since then I am informed by Mr. G. F. Hampson of the British Museum that *hylotomiformis* is the same as *Æ. pyramidalis*. Mr. Hampson's note is as follows: "That *hylotomiformis*= *pyramidalis* there is not the least doubt; the type is a female. The tinge of red on antennæ, the streak on inner area of fore wing and on each side of discocellular band, and the arrangement of yellow bands on abdomen, are quite conclusive." The species and varieties now stand as follows:[1]

ALBUNA PYRAMIDALIS *Walker.*
*hylotomiformis* WALKER.
*vancouverensis* HY. EDWARDS.
var. MONTANA *Hy. Edwards.*
*tanaceti* HY. EDWARDS.
var. RUBESCENS *Hulst.*
var. COLORADENSIS *Hy. Edwards.*
*torva* HY. EDWARDS.

*Habitat:* Nova Scotia, Canada, and Maine to Massachusetts, westward to the Pacific.

[1] See Bull. Am. Mus. Nat. Hist., Vol. VI, pp. 89–91.

## Albuna modesta *Kellicott.*

*Albuna modesta* KELLICOTT, Can. Ent. Vol. XXIV, 1892, p. 46.

I have not had the opportunity of seeing this species, and therefore am not able to tell whether it is an *Albuna* or a *Sesia*. In the Museum Bulletin, Vol. VI, p. 92, I expressed the opinion that *Albuna modesta* was the same as *Sesia albicornis*, but a comparison of the types is necessary to definitely decide this question.

## Sesia giliæ (*Hy. Edw.*).

*Ægeria giliæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 200.
*Albuna vitrina* NEUMOEGEN, Ent. News, Vol. II, 1891, p. 109.
*Ægeria deceptiva* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 93.

The type of *S. giliæ* is a female, and the species described as *Albuna vitrina* is a male, and is in my opinion nothing more than the male of the former. *Vitrina* is not an *Albuna*, but must be referred to the genus *Sesia*. In the Museum Bulletin, Vol. VI, p. 367, I erroneously united *vitrina* with *Albuna pyramidalis*, considering it to be merely one of the varieties of the latter species. Since then I have had the opportunity of examining the type of *vitrina*, and find that it is distinct from *Albuna pyramidalis*, and that the species described by me as *Ægeria deceptiva* is the same as *vitrina*. The original description of *vitrina* is misleading, no mention being made of the yellow bands on the abdomen.

*Male.*—Head blackish brown, front whitish ; palpi yellow mixed with black hair outside ; thorax blackish, with the posterior edge of the patagia yellow ; abdomen blackish with a yellow band on the second, fourth, sixth and seventh segments ; anal tuft black on top, yellow beneath and in the middle above. Legs yellow with a black band on the tibiæ ; femora black. Underside of abdomen with the bands from above repeated and the segments between scaled with yellow. Wings transparent with narrow blackish brown borders and discal bar. Underside of wings with costal border and discal bar yellow. Expanse, 20 mm.

*Female.*—Like the male, but differs as follows : Palpi wholly yellow ; margins of wings brown ; discal bar with an orange spot. Abdomen with a yellow band on the upper side of the second, fourth and sixth segments ; underside of abdomen similar to that of the male. Expanse, 24–29 mm.

*Habitat :* Colorado, Montana, and Calgary, British Columbia.

## Sesia mellinipennis *Boisduval.*

*Sesia mellinipennis* BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 402, pl. xiv, 10 B. fig. 12 ; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 96.
*Albuna resplendens* HY. EDWARDS, Papilio, Vol. I, 1881, p. 186.
*Albuna artemisiæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 187.
*Ægeria senecioides* HY. EDWARDS, Papilio, Vol. I, 1881, p. 198.

The types of *Albuna artemisiæ* and *Ægeria senecioides* are before me. Both are males and undoubtedly the same species. The only differences are that *artemisiæ* has the bands on the abdomen more distinct and the margins of the wings darker brown. This may be from the more perfect condition of the insect, *senecioides* being somewhat worn through age or flight. *Albuna resplendens* was described as a male, but the type is a female, and I consider it the same as *artemisiæ.* It also agrees very well with the species described and figured by Boisduval as *Sesia mellinipennis*, and I would propose to unite it with this latter species.

*Habitat :* California and Nevada.

## Sesia rileyana (*Hy. Edw.*).

*Albuna rileyana* HY. EDWARDS, Papilio, Vol. I, 1881, p. 187.
*Ægeria hyperici* HY. EDWARDS, Papilio, Vol. I, 1881, p. 195.

*Albuna rileyana* was described from a single female specimen, and *Ægeria hyperici* from two examples, as females, but the types are males, and are undoubtedly the same as *rileyana.* The species fits better in the genus *Sesia* than in *Albuna.* The wings are largely transparent with narrow brown borders. The discocellular spot is bright orange red ; palpi yellow, with a few black hairs at the sides ; abdomen black with six narrow yellow bands. Expanse, 19–25 mm.

*Habitat :* West Virginia, Missouri and Kansas.

## Sesia brunneipennis (*Hy. Edw.*).

*Ægeria brunneipennis* HY. EDWARDS, Papilio, Vol. I, 1881, p. 191.

The type of this species, from the Tepper Collection in the Michigan Agricultural College, was kindly sent to me for exam-

ination by Prof. Barrows through the kindness of Mr. G. C. Davis. The insect is closely related to, if not identical with, *S. rileyana.* It differs from it by having the brown margins of the fore wing much broader, thus making the wings more opaque. The outer portion is almost entirely opaque, with only a few short transparent streaks in the area beyond the orange discocellular spot. This space in *rileyana* is largely transparent. Abdomen with five yellow bands. Expanse, 23 mm.

*Habitat :* West Virginia and North Carolina.

## Sesia mimuli (*Hy. Edw.*).

*Ægeria mimuli* Hy. Edwards, Papilio, Vol. I, 1881, p. 200.

Closely allied to *S. rileyana*, but the bands on the abdomen are pale yellowish white instead of bright yellow. The front of the head is white, as are also the scales on the palpi. The markings on the wings above and beneath are also paler. It is possible that this species may prove to be a climatic variety of *rileyana.* Expanse, 21 mm.

*Habitat :* Colorado.

## Sesia rutilans (*Hy. Edw.*).

*Albuna rutilans* Hy. Edwards, Papilio, Vol. I, 1881, p. 186; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 94.
*Ægeria aureola* Hy. Edwards, Papilio, Vol. I, 1881, p. 194.
*Ægeria hemizoniæ* Hy. Edwards, Papilio, Vol. I, 1881, p. 198.
*Ægeria lupini* Hy. Edwards, Papilio, Vol. I, 1881, p. 192; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 91.
*Ægeria perplexa* Hy. Edwards, Papilio, Vol. I, 1881, p. 192.
*Ægeria impropria* Hy. Edwards, Papilio, Vol. I, 1881, p. 193.
*Ægeria washingtonia* Hy. Edwards, Papilio, Vol. I, 1881, p. 197.
*Ægeria madariæ* Hy. Edwards, Papilio, Vol. I, 1881, p. 201 (in part).

*Male.*—Head black ; palpi yellow, with a black stripe outside ; collar and underside of thorax yellow ; thorax above black with the patagia tipped with yellow at the posterior end. Legs yellow banded with black. Fore wings broadly bordered with blackish brown ; between the veins, along the outer border, are traces of yellowish rays. The basal transparent space is small and

triangular; discocellular spot large with the clear space beyond small and round. Hind wings transparent, bordered with blackish brown and a few yellow hairs at the base of the inner margin. Abdomen blackish brown with a rather broad yellow band at the posterior edge of the second and fourth segments. Underside of fore wings streaked with golden yellow between the veins of the opaque portion; hind wings with a narrow golden yellow border preceding the brown fringes. Abdomen edged along each side with yellow points. Anal tuft flat, black above, orange at the sides and middle beneath. Expanse, 18–21 mm.

*Female.*—Head black; palpi and collar yellow; thorax black above, with a yellow stripe along each side and a small transverse spot on the posterior portion; thorax beneath yellow. Abdomen black, a yellow band on the second, fourth, fifth and sixth segments, sometimes the band on the fifth segment wanting. Legs yellow, banded with black; tarsi yellow. Fore wings blackish brown, bright orange between the veins. The orange scales almost obscure the transparent portions of the wings. Hind wings transparent, very narrowly bordered with brown and golden yellow; fringes brown. Anal tuft bunch-like, yellow, black at the base in the middle above. Underside of fore wings almost entirely clear pale orange yellow with only the discocellular spots, the outer veins and fringes brown. Hind wings with the orange border broader than above. Abdomen with the bands repeated. Expanse, 17–21 mm.

*Habitat:* California, Nevada, Washington, Texas and Colorado.

The above descriptions were taken from three bred males and three females from the collection of the U. S. National Museum, sent me through the kindness of Mr. L. O. Howard. The species lives in the roots of the Strawberry, as recorded by the late C. V. Riley (Proc. Ent. Soc. Wash., Vol. I, p. 85).

Mr. J. J. River has bred the species from the roots of the garden Raspberry and cultivated Blackberry (Ent. Amer., IV, p. 99). He also states that the male sometimes has three abdominal bands of pale yellow, and when three are present the third is at the base of the anal tuft. Another variation shows a tendency in the male to imitate the dorsal markings of the female by having well-developed bands on the second, fourth and sixth segments, and on the dorsum of all the other segments is to be seen a cluster of yellow scales, forming a nucleus of a yellow band.

The species described as *perplexa*, *lupini*, *impropria* and *washingtoniæ* are males, and *hemizoniæ*, *areola* and *rutilans* are the females. The specimen described as the male of *madariæ* is the male of *rutilans*, and the female is probably a distinct species.

## Sesia madariæ (*Hy. Edw.*).

*Ægeria madariæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 201.

Head black, collar and palpi yellow ; thorax black, with a yellow stripe along the inner edge of the patagia, and a yellow mark at the posterior edge. Abdomen with a yellow band on the second and fourth segments. Fore wings purplish black, with the transparent spaces very small. Hind wings transparent, with the violet black border narrow. Underside of fore wings largely golden yellow. Expanse, 15 mm.

*Habitat:* California.

Two females of this species are in the Hy. Edwards Collection, and they look very much like the male of *Sesia rutilans*.

## Sesia neglecta (*Hy. Edw.*).

*Ægeria neglecta* HY. EDWARDS, Papilio, Vol. I, 1881, p. 197.

Allied to *S. madariæ*, but the fore wings are almost entirely opaque, with only a very small transparent space in the cell and beyond the discal spot; between the veins on the outer portion the fore wings are streaked with dull yellow. Otherwise it is the same as *S. madariæ*, and is probably the same species, but more material is required to verify my suspicion. Expanse, 16 mm.

*Habitat:* Washington, California and Nova Scotia.

## Sesia refulgens (*Hy. Edw.*).

*Ægeria refulgens* HY. EDWARDS, Papilio, Vol. I, 1881, p. 199.

Head and antennæ black ; palpi and collar yellow ; thorax black, with a yellow band across the posterior portion and a few yellow hairs at the posterior end of the patagia. Abdomen black, with a yellow band on the second, fourth and sixth segments, and faint traces of another yellow band on the fifth segment. Anal tuft black, yellow at the sides above. Legs yellow and black, femora black, tibiæ yellow, with a black band. Fore wings violet brown, marked with orange in the transparent portion ; discal spot orange outside. Hind wings transparent, with a narrow violet brown border. Underside of fore wings bright orange between the veins and along the costa of the hind wings. Expanse, 18 mm.

*Habitat:* Georgia.

The type is in the Tepper Collection in the Agricultural College of Michigan, and was sent to me for examination by Prof.

Barrows. It is a female and not a male, as described by Hy. Edwards. It is closely related to *S. rutilans*, but the fore wings are narrower, and the discal spot is orange outside and the patagia are tipped with yellow. It also lacks the orange on the border of the hind wings.

## Sesia novaroënsis (*Hy. Edw.*).

*Ægeria novaroënsis* BEHRENS MS. HY. EDWARDS, Papilio, Vol. I, 1881, p. 199.

Head, palpi and collar bright orange ; thorax above black, patagia orange, as is also the underside. Abdomen black, with a bright orange band on each segment ; underside of abdomen wholly orange. Legs orange, with black rings. Fore wings transparent, with a blue black narrow border; transverse discal spot blue black. Hind wings transparent, with a narrow blue black border. Expanse, 30–35 mm.

*Habitat:* California and Oregon.

The specimen described by Hy. Edwards as the male of this species is a female. It is the largest *Sesia* known in this country at present. The male is unknown.

## Sesia bassiformis *Walker.*

*Ægeria* (*Paranthrene*) *bassiformis* WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 39.
*Trochilium* (*Paranthrene*) *bassiformis* MORRIS, Synop. Lepid. N. Am. 1862, p. 331 (quotes Walker).
*Sesia bassiformis* BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 434 (quotes Walker).
*Ægeria bassiformis* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 24.

In the Museum Bulletin, Vol. V, p. 25, and Vol. VI, p. 92, I united *Æ. sexfasciata*, *consimilis*, *eupatori*, *infirma* and *bolli* with *Æ. lustrans* after an examination of the types. Since then the type of *Æ. imitata* was examined, and the insect must also be referred to *lustrans*. In my opinion *Æ. bassiformis* Walker is nothing more nor less than a worn example of the male of *Æ. lustrans*. Mr. Hy. Edwards's note on the type of *bassiformis*,[1] which was seen by him in the British Museum, is as follows : "It is very like *Ægeria lustrans* Gr., but blacker. This may be

[1] Bull. Am. Mus. Nat. Hist., Vol. V, p. 24.

from imperfect condition. It has four narrow bands on the abdomen, and one a little wider at the base." Recently I received from Mr. Hampson a colored sketch of the type of *bassiformis*, and it agrees very well with the types of *Æ. eupatori* and *Æ. consimilis*, both of which are worn examples of *Æ. lustrans*. I therefore propose to unite *lustrans* with *bassiformis*. The bands of this insect soon become abraded through flight, after it emerges from the pupa, and the older the insect becomes the blacker it gets, and as a consequence specimens may be found with one, two, three, or the usual number (six) bands, or without any. Thus more or less worn individuals may be readily mistaken for different species. The larva lives in the stems of *Eupatorium*.

The synonomy of the species is now as follows :

SESIA BASSIFORMIS *Walker.*
*lustrans* GROTE.
*sexfasciata* HY. EDW.
*consimilis* HY. EDW.
*eupatorii* HY. EDW.
*infirma* HY. EDW.
*imitata* HY. EDW.

*Habitat :* Massachusetts and New York to Texas.

## Sesia rubrofascia (*Hy. Edw.*).

*Ægeria rubrofascia* HY. EDWARDS, Papilio, Vol. I, 1881, p. 191.
*Ægeria bolteri* HY. EDWARDS, Papilio, Vol. III, 1883, p. 155.

*Ægeria bolteri* was originally described as a male, but the type which is before me is a female, and I regard it as the female of *Ægeria rubrofascia.* Expanse, 18–20 mm.

*Habitat :* Georgia and Northern Illinois.

## Sesia pictipes (*Hy. Edw.*).

*Ægeria pictipes* GROTE & ROBINSON, Trans. Amer. Ent. Soc. Phila. Vol. II, 1868, p. 182.
*Ægeria inusitata* HY. EDWARDS, Papilio, Vol. I, 1881, p. 201.

Both sexes of this species are very much alike, and resemble the male of *Sanninoidea exitiosa*, of which the female has opaque

wings. *S. pictipes* has the wings largely transparent, the border blue black and very narrow. The abdomen is blue black, with a very narrow yellow band on the upper side of the second segment and one on the underside of the fourth segment, by means of which it may be readily separated from *exitiosa*. The latter also has a wedge-shaped anal tuft, while that of *pictipes* is merely a straight bunch of hairs. The larva lives under the bark of Plum, Wild Cherry (*Prunus serotina*), *Prunus pennsylvanicus*, Juneberry (*Amelanchier canadensis*) and Beach Plum (*Prunus maritima*). Expanse, 17–26 mm.

*Habitat:* Canada, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Illinois and California.

## Sesia fulvipes (*Harris*).

*Ægeria fulvipes* HARRIS, Am. Journ. Sci. and Arts, Vol. XXXVI, 1839, p. 312.

Head black, antennæ orange before the tip, beneath palpi orange, black inside; thorax black, with an orange spot on each side beneath. Abdomen black, with the three basal segments beneath orange. Legs orange, with the femora black. Wings with very narrow black borders. The female has the outer border of the fore wings somewhat broader than the male, and the first two segments are black in the middle and orange at the side, third segment wholly orange; the abdomen above is wholly black, as in the male. Expanse, 22 mm.

*Habitat:* Massachusetts and Canada.

## Sesia saxifragæ (*Hy. Edw.*).

*Ægeria saxifragæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 190; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1895, p. 91.
*Ægeria henshawi* HY. EDWARDS, Papilio, Vol. II, 1882, p. 56.

Allied to *S. fulvipes*, but differs from it by having the abdomen wholly black above and below, the borders of the fore wings broader, and by the absence of the orange before the tip of the antennæ beneath. At the base of the wings are a number of orange scales, as well as on the underside of the fore wings. Expanse, 20–22 mm.

*Habitat:* Labrador and Colorado.

## Sesia albicornis (*Hy. Edw.*).

*Ægeria albicornis* Hy. Edwards, Papilio, Vol. I, 1881, p. 201; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 92.
*Ægeria proxima* Hy. Edwards, Papilio, Vol. I, 1881, p. 201.

*Male.*—Head black, palpi white beneath; antennæ black, sometimes with a white patch before the tip; thorax black with a narrow yellow line on each side, and a yellow spot on each side beneath. Abdomen black above, steel blue black beneath; anal tuft black edged with white on each side and white in the middle beneath. Legs steel blue, fore coxa white, and the spurs and tufts on the joints white. Fore wings with the outer border sometimes marked with yellow between the veins; costal margin narrow; transverse discal mark violet black. Underside of fore wings streaked with yellow in the opaque portion. Hind wings transparent, with a narrow black border. Expanse, 17–19 mm.

*Female.*—Wholly bronzy black, with the antennæ marked more or less with white before the tip. Costa on the fore wings beneath scaled with yellow. Legs with the joints tufted with white, spurs also white. Expanse, 22 mm.

*Habitat:* New York to California and Oregon.

The species has been reared from larvæ found under the bark of Willow (Proc. Ent. Soc. Wash., Vol. I, p. 85). I have also bred it from the trunks of low willows, which were infested with *Cryptorhynchus lapathi.* In a female example from Colorado the palpi are pale yellow beneath instead of black.

## Sesia culiciformis var. americana, var. nov.

*Ægeria culiciformis* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 93.

Wings transparent, with the black margins and discal transverse mark on the fore wings metallic blue black. Head, antennæ, thorax and rest of body also metallic blue black, except the base of fore wings and the palpi orange; the fourth segment of the abdomen is red above and below, and on each side of the thorax beneath is an orange spot. The tarsi are also slightly tinged with pale orange. In one example there is a red stripe on each side of the abdomen from the base to the red fourth segment. Expanse, 21–24 mm.

*Habitat:* Nevada and British Columbia.

This form was first recorded by me as occurring in this country from a specimen in the collection of Mr. Charles Palm, from the Cascade Mountains, British Columbia.

It differs from the typical European *culiciformis* by the absence of the orange scales at the base of the fore wings above, and by having only the base of the fore wings beneath orange, while in the European form the dark portion beneath is almost entirely golden orange yellow. It also differs by having the legs entirely blue black, and lacking the pale orange patch on the hind tibiæ. It is also darker and more metallic blue. Since the record of this variety I have received from Mr. H. F. Hillman, from Reno, Nevada, a branch of Alder, from which emerged four specimens of this beautiful insect.

## Sesia tepperi (*Hy. Edw.*).

*Pyrrhotænia tepperi* Hy. Edwards, Papilio, Vol. I, 1881, p. 203.

Head orange, with a white spot before each eye; palpi, thorax above and below, underside of abdomen, first segment above and anal tuft deep orange; remaining segments above blue black. Fore wings metallic blue black, cell transparent; area beyond discal spot very small. Expanse, 22 mm.

*Habitat:* Georgia.

The type is in the Tepper Collection in the Agricultural College of Michigan, and was sent to me by Prof. Barrows. It is a female, and not a male, as described by Hy. Edwards, and is generically the same and allied to *S. culiciformis.*

## Sesia aureopurpurea (*Hy. Edw.*).

*Ægeria* (?) *aureopurpurea* Hy. Edwards, Bull. Brooklyn Ent. Soc. Vol. III, 1880, p. 72.

Fore wings opaque, violet brown, with a few short, yellow streaks before the outer margin. Hind wings transparent, border narrow, violet brown. Head black, palpi yellow. Thorax blackish brown, with a narrow yellow stripe on each side. Abdomen violet brown, with a narrow yellow ring on the first, second, fourth and anal segments. Anal tuft violet brown, yellow in the middle beneath. Antennæ with a white patch before the tip. Undersides of wings same as above, but the fore wings are much brighter and more metallic. Expanse, 12 mm.

*Habitat:* Texas.

## Sesia acerni (*Clem.*).

This is the well-known Maple borer, to which trees the larvæ are especially destructive. The moth emerges early in the morning and flies as soon as the wings are expanded and dried. The male moth, according to Mr. L. H. Joutel, when in search of the female, flies up and down the trunk of the tree, very much like the males of the Ichnenmon Fly (*Thalessa lunator*).

## Sesia corni (*Hy. Edw.*).

*Ægeria corni* Hy. Edwards, Papilio, Vol. I, 1881, p. 190; Kellicott, Can. Ent. Vol. XXIV, 1892, pp. 46 and 210; Insect Life, Vol. V, 1892, p. 83.

*Male.*—Head black, palpi orange, last joint black outside; collar orange; antennæ black, with a whitish patch outside before the tip; thorax black above; patagia mixed with yellow hairs; yellow beneath; abdomen black, with a very narrow yellow ring at the posterior edge of the second, fourth, fifth and sixth segments; underside of last three segments pale yellow; anal tuft orange, black above and laterally at the base; coxæ yellow, femora, tibiæ and tarsi black, yellow inwardly, spurs yellow. Fore wings transparent, costa with a narrow black margin, apical portion broadly black; discal mark large and broad. Hind wings transparent, with a very narrow black border. Expanse, 17–20 mm.

*Habitat:* New York, Massachusetts and Ohio.

Allied to *S. acerni.* According to Prof. D. S. Kellicott, the female is the same as the male in general color, but differs in having less black at the tips of the palpi, and in having much more golden on the abdomen beneath, this color extending over the dorsum so that nearly all the segments are faintly edged, and the fourth has a broad band. It also lacks the black in the anal tuft, which is reddish orange. A female in the collection of Rev. J. L. Zabriskie has the bands on the abdomen all very narrow. The larva lives under the bark of Maple.

## Sesia tipuliformis (*Linn.*).

This well-known species is found in this country from the Atlantic to the Pacific coast. In its larval stage it lives in the stems of the cultivated Currant, and according to Dr. Staudinger it also lives in the young shoots of Hazel (Stettin Ent. Zeitsch., Vol. XVII, p. 202).

## Sesia pyri (*Harris*).

*Trochilium pyri* HARRIS, New England Farmer, Vol. IX, 1830, p. 2.
*Ægeria pyri* HARRIS, Am. Journ. Sci. and Arts, Vol. XXXVI, 1839, p. 313.
*Sesia pyri* BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 440.
*Ægeria kœbelei* HY. EDWARDS, Papilio, Vol. I, 1881, p. 196.

*Male.*—Head black, orbits white ; palpi yellow beneath, black above ; antennæ with a dull yellow patch before the tip, but mostly always entirely black. Thorax black above, yellow at the sides beneath. Abdomen blue black, with a narrow yellow ring at the posterior edge of the second and fourth segments ; underside of abdomen washed with yellow ; anal tuft black, slightly yellow in the middle beneath. Fore wings narrow, margins and the discal bar bronzy brown. Expanse, 14 mm.

*Female.*—Larger than the male, with a clear pale yellow patch on the outside of the antennæ before the tip. Abdomen with a narrow yellow band on the second segment and a broader one on the fourth segment. On the first and second segments laterally is a short yellow stripe. Fourth segment beneath wholly yellow. Anal tuft black, with a bunch of yellow hairs on each side above. Legs largely black, with narrow yellow bands. The underside of the fore wings with more and brighter yellow along the costa and outer portion. Expanse, 18 mm.

*Habitat :* Canada to Florida, and westward.

The type of *Æ. kœbelei* I regard to be nothing more than a worn male of *Sesia pyri*. The larva lives under the bark of Pear and Apple.

## Sesia scitula (*Harris*).

*Ægeria scitula* HARRIS, Am. Journ. Sci. and Arts, Vol. XXXVI, 1839, p. 313 ; WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 45 ; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 94.
*Trochilium scitula* MORRIS, Synop. Lepid. N. Am. 1862, p. 141.
*Sesia scitula* BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 439.
*Trochilium gallivorum* WESTWOOD, Gardener's Chronicle, 1854, p. 757 ; Proc. Ent. Soc. Lond. (2) III, 1854, p. 21 ; HY. EDWARDS, Papilio, Vol. II, 1882, p. 97 ; KELLICOTT, Can. Ent. Vol. XXIV, 1892, p. 45.
*Trochilium hospes* WALSH, Proc. Ent. Soc. Phila. Vol. VI, 1866, p. 270 ; PACKARD, Fifth Rep. U. S. Ent. Comm. 1890, pp. 217, 270 and 296.
*Ægeria æmula* HY. EDWARDS, Papilio, Vol. III, 1883, p. 155.

*Male.*—Head black, with a silvery white line before each eye ; palpi yellow, tip black ; antennæ steel blue black ; thorax blue black, with a narrow yellow line on the patagia. Abdomen steel blue black, with a narrow yellow band on posterior edge of the second segment above and a broader band on the sixth

segment, which is also present on the underside ; anal tuft black, yellow at the sides ; at the base of the abdomen on each side is a short narrow yellow stripe terminating at the band in the second segment. Legs yellow, middle and hind femora black, and a purple band at the end of the middle and hind tibiæ. Fore wings transparent, costal border very narrow, outer border broader and marked with yellow between the veins ; discal bar narrow, violet. Hind wings with border very narrow. Undersides of the wings similar to the upper ; underside of abdomen marked with yellow on the last three segments. Expanse, 19–20 mm.

*Female.*—Similar to the male, but larger and heavier. The palpi are wholly yellow and the fourth segment is wholly yellow above and below ; the fifth and sixth are yellower beneath ; on the fore wings the yellow between the veins of the outer border is also more distinct, and the anal tuft is yellow at the sides above. Expanse, 22 mm.

*Habitat:* New York, New Jersey, Virginia, Massachusetts, Canada and Illinois.

This species has been bred from Oak Galls (*Andricus cornigerus*) by Rev. J. L. Zabriskie, and by me from under bark of Chestnut. Walsh bred it from a Willow gall, and specimens from Oak and Hickory galls, which he doubtfully referred to *S. scitula* (*hospes*). Mr. L. H. Joutel bred it from the trunk of Dogwood (*Cornus florida*). It is closely allied to *S. pyri*, but the legs are largely yellow ; the thorax has a yellow stripe on each side ; the antennæ lack the white patch, and the female has the fourth segment wholly yellow above and below. The types of *Ægeria æmula* from the Riley Collection were sent to me by Mr. Howard, and they are the males of *scitula*. Dr. Riley bred them from larvæ found in November under the bark of an old Oak. They emerged May 22 and 24.

## Sesia corusca (*Hy. Edw.*).

*Ægeria corusca* Hy. Edwards, Papilio, Vol. I, 1881, p. 193.

Bronzy brown, with a violet reflection. Head bluish black, white in front ; palpi yellow ; collar yellow ; thorax with a narrow yellow line laterally ; abdomen with a narrow yellow band on the first, second, third, fourth and sixth segments. Anal tuft yellow at the sides. Fore wings with transparent area beyond the discal mark, small and round ; outer portion streaked with yellow between the veins. Expanse, 14 mm.

*Habitat:* Texas.

Allied to *S. pyri*, but differs by the bands on the abdomen and in having the outer transparent space on the fore wings round, while in *pyri* it is quadrate.

## Sesia decipiens *Hy. Edw.*

*Ægeria decipiens* Hy. Edwards, Papilio, Vol. I, 1881, p. 187.
*Ægeria nicotianæ* Hy. Edwards, Papilio, Vol. I, 1881, p. 202.

In this Bulletin, Vol. VI, p. 367, I united *Ægeria imperfecta* with *Ægeria decipiens*, there being no sufficient characters to warrant their separation as distinct species. Since then I have carefully studied the type of *Ægeria nicotianæ* and find that it must also be referred to *decipiens*. It only differs by being somewhat smaller. *Decipiens* and *nicotianæ* are males, while *imperfecta* is undoubtedly the female.

*Habitat:* Colorado and Texas.

## Sesia rubristigma (*Kellicott*).

*Ægeria rubristigma* Kellicott, Can. Ent. Vol. XXIV, 1892, p. 212; Insect Life, Vol. V, 1892, p. 84; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 94.

An example of this species was kindly sent to me by Prof. D. S. Kellicott, who bred the same from the galls on Oak (*Quercus palustris*). It is a good species, allied to *S. decipiens*, and not identical with the example recorded by the late Hy. Edwards as the European *asiliformis*, as I supposed.

*Habitat:* Ohio.

## Sesia querci (*Hy. Edw.*).

*Ægeria querci* Hy. Edwards, Papilio, Vol. II, 1882, p. 98.

Allied to *decipiens*, but a much more delicate insect. The margins of the wings are very narrow and the antennæ are thicker. The palpi are black outside and white inside and at the tip. The abdomen has five yellow bands, the one on the fourth segment almost as broad as the segment. Expanse, 12 mm.

*Habitat:* Arizona.

The Moth has been bred from galls found on Live Oak.

### Sesia prosopis (*Hy. Edw.*).

*Ægeria prosopis* Hy. Edwards, Papilio, Vol. II, 1882, p. 99.

A good species and different from all the known American species. It has the margins of the wings, head, antennæ and body deep black. The palpi are white beneath, with the last joint and above black. The legs are black, with the coxæ of the anterior pair, joints and spurs white. The fringes of the hind wings are also white. Has been raised from galls found on Mesquite.

*Habitat:* Arizona.

### Sesia tecta (*Hy. Edw.*).

*Ægeria tecta* Hy. Edwards, Papilio, Vol. II, 1882, p. 56.

The type is in the Neumoegen Collection and has been examined by me. It is allied to *S. rubristigma*. The margins of the wings are very narrow; the discal bar is straight, very narrow, and yellow outside. The black abdomen has four yellow bands, one on the second segment, a broader one on the fourth segment, and one on each of the sixth and seventh segments. Expanse, 16 mm.

*Habitat:* Arizona.

### Sesia morula (*Hy. Edw.*).

*Ægeria morula* Hy. Edwards, Papilio, Vol. I, 1881, p. 196.

Only a single specimen of this species is known to exist, and the type is in the Neumoegen Collection. It is a distinct species.

*Habitat:* Texas.

### Sesia verecunda (*Hy. Edw.*).

*Ægeria verecunda* Hy. Edwards, Papilio, Vol. I, 1881, p. 190.

A very distinct and aberrant species. The types are females and the male is unknown, and when known probably a new genus will have to be erected for the species.

*Habitat:* Colorado.

### Sesia edwardsii *Beuten.*

*Ægeria edwardsii* Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 92.

A distinct species allied to *Sesia verecunda*.

*Habitat:* Colorado.

## Sesia candescens (*Hy. Edw.*).

*Ægeria candescens* HY. EDWARDS, Papilio, Vol. II, 1882, p. 123.

Only known by a single male in the Neumoegen Collection. It is a good species.

*Habitat:* Arizona.

## Pyrrhotænia behrensii *Hy. Edw.*

*Pyrrhotænia behrensii* HY. EDWARDS, Papilio, Vol. II, 1882, p. 123; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 26.
*Pyrrhotænia elda* HY. EDWARDS, Ent. Am. Vol. I, 1885, p. 49.

The specimens described as *P. behrensii* are the males of *P. elda*.

*Male.*—Head black, with a green lustre; palpi red; thorax metallic blue black; fore wings opaque, metallic blue black, inner margin bright red. Hind wings transparent, with a very narrow border, fuscous, bright red at the base along the inner margin. Abdomen blue black on the back of the first, second and third segments; remaining parts of the abdomen bright red. Anal tuft blackish on each side above. Expanse, 19–22 mm.

*Female.*—Similar to the male, but the hind wings are entirely covered with bright red scales.

*Habitat:* California.

## Pyrrhotænia fragariæ *Hy. Edw.*

*Pyrrhotænia fragariæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 202; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 26, and Vol. VI, 1894, p. 95.
*Pyrrhotænia helianthi* HY. EDWARDS, Papilio, Vol. I, 1881, p. 203.
*Pyrrhotænia orthocarpi* HY. EDWARDS, Papilio, Vol. I, 1881, p. 204.

In the Museum Bulletin, Vol. V, p. 26, and Vol. VI, p. 95, *P. helianthi* and *P. orthocarpi* were united by me with *P. fragariæ*.

*Male.*—Head black; palpi orange; thorax metallic green; posterior tips of patagia orange; abdomen metallic green black; fourth, sixth and seventh segments on top and lateral edges of all the segments orange red; anal tuft orange red, black on each side above. Fore wings with borders and transverse discal mark metallic green black; transparent space in cell small, triangular, and the space beyond the discal mark rounded with the veins marked with green black; along the inner margin to about the middle of the wing runs an orange red streak. Hind wings transparent, costal margin orange, outer border fuscous. Expanse, 19 mm.

*Female.*—Similar to the male, but the fore wings are covered with metallic blue black scales, sometimes showing very slight traces of transparent spaces.

Hind wings transparent basally and orange outwardly, with the border and fringes fuscous. Expanse, 19–22 mm.

*Habitat :* Colorado and Nevada.

## Pyrrhotænia præstans (*Hy. Edw.*).

*Ægeria præstans* Hy. Edwards, Papilio, Vol. II, 1882, p. 98.

This species looks much like *P. fragariæ*, but is larger, and is marked with orange in the cell and streaked with this color in the area beyond the discal mark. Expanse, 23 mm.

*Habitat :* Washington.

The type, a single male, is in the Neumoegen Collection.

## Pyrrhotænia polygoni *Hy. Edw.*

*Pyrrhotænia polygoni* Hy. Edwards, Papilio. Vol. I, 1881, p. 202 ; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 95.
*Pyrrhotænia meadii* Hy. Edwards, Papilio, Vol. I, 1881, p. 204.

This species was erroneously described as a male. The type is a female, and the examples described as *P. meadii* I consider to be the males of *P. polygoni.*

*Male.*—Head and thorax metallic blue or green black ; palpi bright red, tips black ; thorax beneath with a red spot on each side anteriorly ; abdomen metallic blue or green black ; fourth, sixth and seventh segments bright red ; lateral edge of abdomen also red ; underside blue black. Fore wings metallic blue or green black ; inner margin, to a little beyond the middle of the wing, red. Expanse, 18–20 mm.

*Female.*—Like the male, but has the hind wings red with a narrow border and fringes fuscous. Thorax with a red stripe on each side. Expanse, 20 mm.

*Habitat :* California.

## Pyrrhotænia achillæ *Hy. Edw.*

*Pyrrhotænia achillæ* Hy. Edwards, Papilio, Vol. I, 1881, p. 203.
*Pyrrhotænia eremocarpi* Hy. Edwards, Papilio, Vol. I, 1881, p. 203.

The only difference between the types of *P. achillæ* and *P. eremocarpi* is in size. Their markings and colors are absolutely identical. The expanse of *achillæ* is 15 mm., and of *eremocarpi* 18 mm. The insect is entirely metallic blue black, except the palpi at base, a spot on each side of the anterior part of thorax beneath, tips of patagia, a streak along inner margin of fore wings, and the middle of the anal tuft, red.

*Habitat :* California.

## Pyrrhotænia texana *Hy. Edw.*

*Pyrrhotænia texana* HY. EDWARDS, Papilio, Vol. I, 1881, p. 204; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 26.
*Pyrrhotænia wittfeldii* HY. EDWARDS, Papilio, Vol. III, 1883, p. 156.

*Male.*—Head black; palpi orange; collar orange; thorax brown with an orange red stripe on each patagia and a transverse mark of the same color on the posterior edge of the thorax; abdomen brown, with an orange red band on the second, fourth, sixth and seventh segments; anal tuft mixed with orange hairs beneath; abdomen beneath orange from the fourth to the last segment. Fore wings brown with the transparent spaces quite small. Hind wings transparent, border very narrow. Expanse, 19–21 mm.

*Female.*—The fore wings are opaque, brown, without the transparent spaces, and the abdomen lacks the orange red band on the sixth segment; anal tuft without orange hairs beneath, otherwise same as the male. Expanse, 22 mm.

*Habitat:* Florida and Texas.

## Pyrrhotænia floridensis *Grote.*

*Pyrrhotænia floridensis* GROTE, Can. Ent. Vol. VII, 1875, p. 174.

*Male.*—Head brown, palpi and collar orange red; thorax brown with an orange red spot on each side beneath and an orange red mark on the posterior edge of the thorax above. Abdomen brown with an orange red band on the second, fourth, sixth and seventh segments; anal tuft brown. Fore wings deep brown, orange red in the cell and in the area beneath the median vein; beyond the indistinct discal mark the wing is also streaked with orange red. Hind wings transparent, border brown, narrow. Legs alternately blue black and orange red. Expanse, 14 mm.

*Female.*—Similarly colored as the male, but the discal spot is distinctly orange, and the abdomen lacks the band on the sixth segment. It is also larger and the wings are broader. Expanse, 18 mm.

Only the type male has hitherto been known. The female was given to us by Mrs. A. T. Slosson, who captured three examples in Florida on Scrub Oaks.

## Pyrrhotænia geliformis (*Walker*).

*Ægeria geliformis* WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 46.
*Pyrrhotænia geliformis* GROTE, New Check List of Moths, 1882, p. 12.

Head, thorax, legs, fore wings and first segment black with a violet blue reflection, remaining segments of abdomen above and below bright red; anal tuft mixed with a little black. Expanse, 15 mm.

*Habitat:* Florida and Mexico.

## Pyrrhotænia sapygæformis (*Walker*).

*Ægeria sapygæformis* WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 45.
*Pyrrhotænia sapygæformis* GROTE, New Check List of Moths, 1882, p. 12.

Allied to *P. geliformis*. Head black, palpi and collar red; thorax black with a red mark posteriorly above and a red spot on each side of the anterior part beneath. Abdomen black, fourth to last segments red above and below; anal tuft black. Legs black and red. Fore wings marked with red in the cell and beneath the median vein. Expanse, 17–19 mm.

*Habitat:* Florida.

## Pyrrhotænia animosa *Hy. Edw.*

*Pyrrhotænia animosa* HY. EDWARDS, Papilio, Vol. III, 1883, p. 156.

*Male.*—Head black; palpi red mixed with black hairs; thorax black, posterior half of patagia red, also a red spot on each side beneath; abdomen blackish, sixth and seventh segments red; lateral edge of abdomen red from fourth to the last segment; anal tuft black laterally. Fore wing greenish black, with a red streak along the inner margin. Hind wings transparent, border narrow, blackish. Expanse, 20 mm.

*Female.*—Differs from the male by being wholly greenish black, except the palpi, inner margin and fore wings and lateral edge of abdomen red. Expanse, 17–19 mm.

*Habitat:* Arizona.

## Pyrrhotænia subærea *Hy. Edw.*

*Pyrrhotænia subærea* HY. EDWARDS, Papilio, Vol. III, 1883, p. 156.

Head and thorax deep brown; antennæ with a yellow spot one-third before the tip; palpi yellowish, abdomen brownish, scaled with yellow, and with traces of bands on the fourth, fifth, sixth and seventh segments; anal tuft mixed with yellow; thorax with a yellow spot on each side of the posterior part. Fore wings purplish brown sprinkled with yellow scales; hind wings purplish brown, transparent at the base; all the wings beneath sprinkled with yellow scales. Expanse, 14 mm.

The type is in the Neumoegen Collection, and is in poor condition, and the original description is too brief for recognition of the species. The above description was taken from a male in fair condition sent to me by Prof. Barrows.

*Habitat:* Arizona.

## Carmenta pyralidiformis (*Walker*).

*Ægeria pyralidiformis* WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 44.
*Carmenta pyralidiformis* HY. EDWARDS, Papilio, Vol. I, 1881, p. 184.
*Sesia nigella* HULST, Bull. Brooklyn Ent. Soc. Vol. III, 1881, p. 75.

Violet brown ; palpi and collar yellow ; thorax with a narrow yellow stripe on each patagia, and a yellow spot on each side of the thorax beneath. Abdomen with the fourth segment bright yellow in the female and in the male with an additional narrow yellow ring on the sixth segment. Fore wings opaque ; hind wings transparent. Expanse, 15–21 mm.

*Habitat:* Canada to Texas.

## Carmenta sanborni *Hy. Edw.*

*Carmenta sanborni* HY. EDWARDS, Papilio, Vol. I, 1881, p. 185.

Bronze black. Fore wings opaque, with a very small white space beyond the cell ; beneath they are yellow for about their basal half and the white spot from above repeated. Hind wings transparent ; palpi, fore femora and posterior edge of the second and fourth abdominal segments yellowish white. Expanse, 18 mm.

*Habitat:* Massachusetts.

## Carmenta nigra *Beuten.*

*Carmenta nigra* BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 95.

Black ; wings opaque ; hind wings somewhat transparent at the base. Palpi, collar, fore femora, and a narrow band on the second, fourth and sixth segments white. The fore wings also marked with white in the cell and in the area beyond the discal spot. Expanse, 15 mm.

*Habitat:* Utah.

## Carmenta ruficornis *Hy. Edw.*

*Carmenta ruficornis* HY. EDWARDS, Papilio, Vol. I, 1881, p. 184.
*Carmenta minuta* HY. EDWARDS, Papilio, Vol. I, 1881, p. 185.

The type of *Carmenta minuta* is in the Tepper Collection in the Agricultural College of Michigan, and was sent to me for examination by Prof. Barrows. It is the male of *Carmenta ruficornis*, the type of which is a female, and not a male, as described by Hy. Edwards.

*Habitat:* Georgia.

### Zenodoxus palmii (*Neumoegen*).

*Larunda palmii* NEUMOEGEN, Ent. News, Vol. II, 1891, p. 108.

This species was described as a *Larunda* (*Gaëa*), but it would be better placed in the genus *Zenodoxus*, to which it is very closely allied if not identical.

*Habitat :* Arizona.

### Zenodoxus canescens *Hy. Edw.*

*Zenodoxus canescens* HY. EDWARDS, Papilio, Vol. I, 1881, p. 205.

A very distinct species, differing from all the rest of the known species of *Zenodoxus*. It is wholly ash gray sprinkled with darker gray. The hind wings are transparent, with a gray border. Expanse, 21 mm.

*Habitat :* Arkansas.

### Zenodoxus heucheræ *Hy. Edw.*

*Zenodoxus heucheræ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 205.
*Zenodoxus potentillæ* HY. EDWARDS, Papilio, Vol. I, 1881, p. 205.

The types of *Zenodoxus heucheræ*, four in number, in the Edwards Collection, are all males, and the types of *Zenodoxus potentillæ*, also four in number, are all females, and I strongly suspect that the latter is nothing more than the other sex of the former. If not, it is very likely only a variety. It differs from *heucheræ* by having a few reddish scales scattered over the wings and the legs banded with red ; in *heucheræ* the scales on the wings and the bands on the legs are yellow. Expanse, 13–18 mm.

*Habitat :* Lake Tahoe, Sierra Nevada, California.

### Zenodoxus maculipes *G. & R.*

*Zenodoxus maculipes* GROTE & ROBINSON, Trans. Am. Ent. Soc. Vol. II, 1868, p. 184.

Allied to *Z. heucheræ*. Bronzy brown ; palpi and collar pale yellowish ; abdomen with a yellowish band on the first and fourth segments ; hind tibiæ with a yellow ring. Expanse, 20 mm.

*Habitat :* Texas.

# Article VIII.—CATALOGUE OF METEORITES IN THE COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY, TO JULY 1, 1896.

By E. O. Hovey.

The Collection of Meteorites in the American Museum of Natural History consists of fifty-five slabs, fragments and complete individuals, representing twenty-six falls and finds. The foundation of the mineralogical department of the Museum was laid in 1874 by the purchase of the collection of S. C. H. Bailey, in which there were a few meteorites. More were acquired with the portion of the Norman Spang Collection of Minerals which was purchased in 1891, and other meteorites have been bought by the Museum from time to time, or have been presented to it by friends. The source from which each specimen came has been indicated in the following catalogue. This publication is made to assist the large number of persons who have become interested in knowing the extent to which the material of various falls and finds has been distributed among collections and the present location of specimens.

## AËROSIDERITES. (Iron Meteorites.)

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| $\frac{13}{5}$ | 1784 | **Tejupilco, Toluca Valley, Mexico.** A complete individual, the surface of which has scaled off somewhat. A polished and etched surface shows coarse Widmanstätten figures. (*Bailey Coll.*) | 1153. |
| $\frac{13}{22}$ | 1784 | **Xiquipilco, Toluca Valley, Mexico.** A complete individual of ellipsoidal form, which had been used as a pounder by the natives. (*Spang Coll.*) | 564. |

AËROSIDERITES.—*Continued.*

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| 13/22 | 1784 | **Xiquipilco, Toluca Valley, Mex.**—*Continued.*<br>An obtusely angular specimen, one side of which has been polished and etched, showing coarse Widmanstätten figures. The original surface has been all scaled off. (*Spang Coll.*)<br>["In 1784 mention was made of the plentiful occurrence of iron in the valley of Toluca. Report of find in Neues Johrb. f. Min. 1856, p. 297." Brit. Mus. Cat. Meteorites, p. 53. 1887.] | 251. |
| 13/11 | Recognized in 1811 | **Elbogen, Bohemia.**<br>A rectangular chiseled and sawed fragment. Shows poor Widmanstätten figures. (*Spang Coll.*)<br>["Preserved for centuries at the Rathhaus of Elbogen; its meteoric origin was recognized by Neumann in 1811. Report of find in Gilb. Ann., 1812, Vol. XLII, p. 197." Brit. Mus. Cat. Meteorites, p. 44. 1887.] | 6.4 |
| 13/16 | 1840 | **Magura, Szlanicza, Arva, Hungary.**<br>A sawed slab showing natural surface on one edge. Etched surface shows small, indistinct markings. (*Spang Coll.*)<br>["Made known by Haidinger in 1844. Pogg. Ann., 1844, Vol. LXI, p. 675." Brit. Mus. Cat. Meteorites, p. 44. 1887.] | 43. |
| 13/14 | Fell July 14, 1847 | **Braunau, Bohemia.**<br>A sawed, cuneiform piece showing part of an original surface pit. (*Spang Coll.*) | 26.4 |
| 13/15 | 1847 | **See-Läsgen, Brandenburg, Prussia.**<br>An irregular, chiseled fragment. (*Spang Coll.*)<br>["Found in draining a field; several years afterward, in 1847, it was recognized by Glocker as meteoric. Report of find in Pogg. Ann., 1848, Vol. LXXIII, p. 329; 1849, Vol. LXXIV, p. 57." Brit. Mus. Cat. Meteorites, p. 43. 1887.] | 18.3 |
| 13/25 | 1853 | **Tazewell, Claiborne Co., Tenn.**<br>Oblong, rectangular, sawed piece. (*Spang Coll.*)<br>Plowed up on a farm about ten miles west of the village in 1853. Described by C. U. Shepard, Am. Jour. Sci., II, xvii, p. 325. 1854. | 52. |

AËROSIDERITES.—*Continued.*

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| $\frac{13}{24}$ | 1858–9 | **Staunton, Augusta Co., Va.** | |
| | | A polished slab 80 x 75 x 6 mm., one surface etched, showing excellent Widmanstätten figures. (*Spang Coll.*) | 217. |
| | | Found in 1858 or 1859 by a colored man named Alf, of the Robert Van Lear plantation, who afterwards threw it away, as he could not sell it for the price he asked (one dollar). After lying neglected for some years it was put with other loose material into a stone wall. Its great weight and irregular shape caused it to fall out of the wall, and it was then used for some time as an anvil. Afterwards it was built into the curbing of a cistern. Here, during the summer of 1877, it was noticed by Mr. M. A. Miller, of Staunton, who obtained it and then disposed of it to Ward and Howell, of Rochester, from whom Mr. Spang procured the slab now in the Museum. Described by J. W. Mallett, Am. Jour. Sci., III, xv, p. 337, 1878, whence the above-given account was taken. | |
| $\frac{13}{10}$ | 1884 | **Glorieta Mt., Santa Fé Co., New Mexico.** | |
| | | A complete individual, irregularly meniscus-shaped. Surface pitted and torn. Etched surface shows Widmanstätten figures. (*Purchased from G. F. Kunz.*) | 24,154. |
| | | A slab 180 x 123 x 5 to 9 mm. in size. Both sides have been etched and show the typical Widmanstätten figures very perfectly. Three edges show the original surface of the mass. (*Purchased from G. F. Kunz.*) | 772. |
| | | Found on a rock on the side of the mountain one mile northeast of the village of Canoncito by a prospector searching for gold. Described by G. F. Kunz, Am. Jour. Sci., III. xxx, p. 235. 1885. | |
| $\frac{13}{26}$ | 1891 | **Cañon Diablo, Arizona.** | |
| | | A polished slab 278 x 137 x 7 to 17 mm. in size, an entire section of the mass. Much cohenite is present, frequently inclosing flakes and plates of schreibersite. Three irregularly ellipsoidal nodules are prominent in the mass. They consist of troilite associated with more or less of a relatively soft graphitic (?) substance, and surrounded by a shell of schreiber- | |

## AËROSIDERITES.—*Continued.*

| Cat. No. | Date of Discovery. | NAME AND DESCRIPTION. | Weight in grams. |
|---|---|---|---|
| | | site, outside of which is a shell of cohenite. The Widmanstätten figures are broad and interrupted, giving the mass an almost granular appearance. (*Purchased from E. E. Howell.*) | 2285. |
| | | A complete individual; in shape an irregular, elongated, four-sided pyramid. (*Purchased from E. E. Howell.*) | 14.7 |
| | | Described by A. E. Foote, Am. Jour. Sci., III, xli, p. 413, 1891, and by O. A. Derby, *Idem*, III, l, p. 101, 1895. | |
| 13/27 | 1893 | **El Capitan Mts., New Mexico.** | |
| | | A polished slab 126 x 124 x 4 to 6 mm. in size, showing the original surface of the mass on all edges. The Widmanstätten figures are long and slender, with occasional broad bands. Many of the interspaces show a second, much smaller set of markings. One large nodule of troilite. (*Purchased from E. E. Howell.*) | 455. |
| | | Described by E. E. Howell, Am. Jour. Sci., III, l, p. 253. 1895. | |
| 13/19 | ? | **Berg Emir, Siberia.** | |
| | | An irregular chiseled piece showing a torn surface. This locality does not appear in Lippincott's Gazetteer. (*Spang Coll.*) | 78. |
| | | Total weight of Aërosiderites..... ..... | 30,089.8 |

## AËROSIDEROLITES. (IRON-STONE METEORITES.)

| Cat. No. | Date of Discovery. | NAME AND DESCRIPTION. | Weight in grams. |
|---|---|---|---|
| 13/2 | 1847 | **Rittersgrün, Erzgebirge, Saxony.** | |
| | | A polished slab in which the stony portion exceeds the metallic. The iron shows delicate Widmanstätten figures. (*Bailey Coll.*) | 26.4 |
| | | A polished piece in which the iron exceeds the stony matter in amount. (*Bailey Coll.*) | 14.2 |
| | | ["Reported by A. Breithaupt in 1861. *Zeitsch. d. deutsch. Geol. Gesell.*, Vol. XIII, | |

AËROSIDEROLITES.—*Continued.*

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| | | p. 148. But according to A. Weisbach it was really found in 1833. '*Der Eisenmeteorit von Rittersgrün in sächsischen Erzgebirge : von A. W. :* Freiberg, 1876.'" Brit. Mus. Cat. Meteorites, p. 57. 1887.] | |
| $\frac{13}{13}$ | 1861 | **Breitenbach, Erzgebirge, Saxony.** | |
| | | An irregular piece, one side of which has been polished and etched. The particles of iron show Widmanstätten figures. The outer surface has been much rusted. The olivine and other stony matter exceed the iron in amount, and the whole seems to be identical with the specimens from Rittersgrün, No. $\frac{13}{2}$. They are probably parts of the same fall. (*Spang Coll.*) | 76. |
| | | Described by N. S. Maskelyne in 1871. *Phil. Trans.*, Vol. CLXI, p. 359. Rittersgrün and Breitenbach are within three English miles of each other, and the aërosiderolites probably fell at the same time. Breithaupt suggests that this was the fall reported to have taken place at Whitsuntide in the year 1164. *Berg. u. hütt. Zeitung*, 1862, Jahrg. XXI, p. 321 : Buchner suggests a fall which took place between 1540 and 1550. *Die Meteoriten*, etc. : *von Otto Buchner :* Leipzig, 1863, p. 124. [Adapted from Brit. Mus. Cat. Meteorites, p. 57. 1887.] | |
| $\frac{13}{3}$ | Fell May 10, 1879. | **Estherville, Emmet Co., Iowa.** | |
| | | Twenty-two complete individuals, ranging in weight from 1.5 g. to 26.2 g. All show the nickel-white, rounded knobs of iron. (*Bailey and Spang Colls.*) | 212.6 |
| | | An irregular mass, apparently showing none of the original crust. (*Purchased from Miss F. A. M. Hitchcock.*) | 138.5 |
| | | An irregular mass like the last, but showing a little of the crust. (*Spang Coll.*) | 58. |
| $\frac{13}{8}$ | ? | **Desert of Atacama, South America.** | |
| | | About half of a spheroidal mass, in which the iron much predominates over the included olivine. Much of the original surface has scaled off, but many of the pits still show. Apparently different from No. $\frac{13}{20}$, and may be the pallasite of Imilac. (*Presented by Mrs. R. L. Stuart.*) | 4876. |

AËROSIDEROLITES.—*Continued.*

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| 13/12 | ? | **Ensicheim, Elbogen, Bohemia.** | |
| | | A very irregular, spongy iron, which has lost its original inclusions, closely resembling the original Pallas iron. (*Spang Coll.*) | 4.5 |
| | | There seems to be some confusion about the locality here, since the meteorite from Ensisheim, Alsace, is an aërolite and that from Elbogen, Bohemia, is a holosiderite. | |
| 13/20 | ? | **Desert of Atacama, South America.** | |
| | | A sharp-pointed, irregular mass of very spongy iron, from which the stony matter has largely decomposed and has fallen out to some extent. Apparently different from No. 13/8. (*Spang Coll.*) | 13.3 |
| 13/21 | ? | **Mount Kemis, Siberia.** | |
| | | An irregular, spongy iron, which has lost its original inclusions. (*Spang Coll.*) | 31. |
| | | This locality does not appear in the Gazetteer. The iron is like the Pallas iron from Medwedewa, Krasnojarsk, Siberia. | |
| | | Total weight of the Aërosiderolites.... .... ... | 5450.5 |

AËROLITES. (STONE METEORITES.)

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| 13/7 | Fell May 1, 1860. | **New Concord, Ohio.** | |
| | | A fragment from the interior, preserving none of the crust. This is a gray rock with minute metallic (iron) points scattered thickly through it. (*Bailey Coll.*) | 44.5 |
| 13/1 | Fell June 9, 1866. | **Knyahinya, near Nagy-Berezna, Hungary.** | |
| | | A sub-rectangular individual with grayish-black skin, which has been removed at one spot showing the gray interior with its minute particles of iron. (*Bailey Coll.*) | 35. |
| | | A complete, rudely wedge-shaped individual preserving its dull black crust nearly entire. The surface is indented with closely-set small pits. The description makes it probable that this is the correct locality for this stone, though none was given on the Spang label. (*Spang Coll.*) | 75.4 |

AËROLITES.—*Continued.*

| Cat. No. | Date of Discovery. | Name and Description. | Weight in grams. |
|---|---|---|---|
| 13/1 | Fell Jan. 30, 1868. | **Pultusk, Poland.** | |
| | | A complete, hemispheroidal individual, preserving its thin rusty-black crust. A chipped place shows the light gray interior with its metallic grains. (*Bailey Coll.*) | 51.2 |
| 13/23 | Fell May 21, 1871. | **Searsmont, Waldo Co., Maine.** | |
| | | A cuboidal fragment from the interior. Light gray rock with numerous small brown patches. Numerous particles of iron are scattered through the mass, and there is one angular piece (part of a crystal ?) of pyrrhotite. (*Spang Coll.*) | 4.2 |
| 13/6 | Fell Feb. 12, 1875. | **Homestead, Iowa Co., Iowa.** | |
| | | A nearly complete individual, roughly pyramidal in shape, showing broad shallow surface pits. The thin, dull-black crust has been broken off in spots, revealing the dark gray interior with minute metallic points scattered through it. This is the fall entered as "West Liberty" in the British Museum catalogue of meteorites. (*Purchased from H. T. Woodman.*) | 583. |
| 13/18 | Fell Feb. 3, 1882. | **Möcz, Transylvania.** | |
| | | A complete, wedge-shaped individual. The comparatively thick, dull-black crust is intersected by a network of fine cracks. The interior is gray with small brown spots in it, and with numerous fine veins and particles of iron scattered through it. (*Spang Coll.*) | 165. |
| | | Two smaller complete individuals presenting the same characters. (*Spang Coll.*) | 24.7<br>11.4 |
| | | Total weight of Aërolites..... ..... | 994.4 |

| | | |
|---|---|---|
| Total weight of | Aërosiderites..... | 30,089.8 |
| " " | Aërosiderolites..... | 5,450.5 |
| " " | Aërolites.... ..... ..... | 994.4 |
| Grand Total..... | | 36,534.7 |

# Article IX.—THE CRANIAL EVOLUTION OF TITANOTHERIUM.

By Henry Fairfield Osborn.

With Plates III and IV, and Fifteen Figures in the Text.

The rapid evolution of the Titanotheres during the deposition of about 180 feet of sediment in the Oligocene White River Beds is one of the striking chapters in mammalian history which is still only partly understood.

The following study of the evolution of the cranium is chiefly an attempt to distinguish the influences of *sex*, of *age* or *growth*, and of *individual variation* from the truly *retrogressive* and *progressive* characters. It is written to this end, but unfortunately we cannot intelligibly treat the morphology of *Titanotherium* without first clearing out the Augean stable of nomenclature. The greater number of the *thirteen* generic and *thirty-one* specific terms which have been proposed are either undefined or undefinable, or are based upon non-specific or non-generic characters.

The materials examined in connection with this study are: Cope's type skulls and jaws now in the American Museum collection; eighteen skulls mostly collected, partly purchased, for the Museum in the expeditions of 1892 and 1894 by Dr. Wortman and Mr. Peterson; the three type skulls in the Harvard University Museum; the few skulls belonging to the U. S. Geological Survey collection[1] in the National Museum at Washington. The author is indebted to Dr. W. D. Matthew for notes upon Marsh's type skulls in the Yale University Museum, also for much valuable assistance.

The illustrations are the work of Rudolph Weber. The majority of the type skulls are shown in the two plates.

---

[1] These skulls are partly determined by Prof. Marsh. By his direction the cases containing them are kept closed, so that only part of their characters can be observed.

# I.—Systematic Introduction.

## Historical Notes.

In 1847 (1) Dr. Hiram A. Prout, of St. Louis, described and figured part of a lower jaw containing the true molars of a huge animal which he supposed to be *Palæotherium*. This specimen, as Leidy later remarked in his 'Ancient Fauna of Nebraska' (p. 72), is noteworthy as "the first fossil from the Eocene cemetery of Nebraska, presented to the notice of the world." In 1849 Pomel (2) recognized the distinct generic character of this jaw and termed it *Menodus*, a term which is technically preoccupied and therefore not employable.[1] In 1850 the same jaw was termed *Palæotherium proutii* by Owen, Norwood and Evans (3), without definition. Shortly afterwards Leidy (4) gave the name *P. bairdii* to another specimen. In 1850 Leidy (5) mentioned one other specimen as *P. giganteum*. In 1852 (7) he partially defined the species *T.* (*Rhinocerus*) *americanus* (Pl. XVII, Figs. 1–4). In the same memoir of 1852 Leidy also first used the name *Titanotherium* without definition, but in 1853 he (8) fully described and figured the jaw in the Owen Collection (Anc. Faun. Neb., Pl. XVI, p. 551, Fig. 1) as the type of the new genus *Titanotherium*, mentioning a third species *T. maximum*.

This established the genus. *None of the above species are determinable.* The terms *T. proutii* and *T. americanum* have been variously cited by Marsh, Cope, Scott and Osborn, but are of no specific value whatever; the lower teeth and jaws upon which they are based are incomplete and uncharacteristic; the types have been partly destroyed by fire.[2]

The upper teeth and skull were still unknown. In 1859 Leidy (9) described the palate and superior molars (found by Meek and Hayden in Nebraska, now in the Hall Collection, American Museum of Natural History) as those of a huge *Anoplotherium*.

---

[1] As Marsh noted in 1873, "The generic name *Titanotherium* Leidy is antedated by *Menodus* Pomel (Bib. Univ. de Geneve, X, p. 75, Jan., 1849). The latter, however, is essentially the same word as *Menodon*, von Meyer, 1838. Hence *Titanotherium* should be retained."

[2] Prout's collection was partly burnt in Burlington, Iowa. A portion of it went to Chicago and was destroyed in the Chicago fire.

## Table I.—Chronological List of Terms.

| | | | |
|---|---|---|---|
| (1) | Palæotherium | *Prout* | Am. Jour. Sci., 1846, II, p. 288 ; 1847, p. 248. |
| (2) | Menodus | *Pomel* | Bib. Univ. de Geneve, X, p. 75, Jan., 1849. |
| (3) | Palæotherium proutii | *Owen* | Owen, Norwood, Evans., Proc. Acad. Nat. Sci., 1850, p. 66. |
| (4) | " bairdii | *Leidy* | " " " " " " " p. 122. |
| (5) | " giganteum | " | Owen's Rep. Geol. Surv. Wisc., Ref. to Pl. XIIB, figs. 3, 4. |
| (6) | Titanotherium (Rhinocerus) americanus | " | Proc. Acad. Nat. Sci., 1852, p. 2. |
| (7) | " proutii | " | Anc. Faun. Neb., 1853, p. 76 (Owen's Rep., p. 551). |
| (8) | " maximum | " | " " " p. 78. |
| (9) | Anoplotherium | " | Ext. Faun. Dak. and Neb., 1859, p. 206. |
| (10) | Leidyotherium | *Prout* | Trans. Acad. St. Louis, 1860, p. 699. |
| (11) | Megacerops coloradensis | *Leidy* | Proc. Acad. Nat. Sci., 1870, p. 1. |
| (12) | Brontotherium gigas | *Marsh* | Am. Jour. Sci., June, 1873, p. 486. |
| (13) | Symborodon torvus | *Cope* | Palæon. Bull. No. 15, Aug. 20th, 1873, p. 2. |
| (14) | " (Miobasileus) ophryas | " | " " " " p. 3. |
| (15) | Megaceratops acer | " | " " " " p. 4. |
| (16) | " heloceras | " | " " " " p. 4. |
| (17) | Symborodon bucco | " | Syn. New Vert. Tert. Col., Oct., 1873, p. 10. |
| (18) | " altirostris | " | " " " " p. 12. |
| (19) | " trigonoceras | " | " " " " p. 13. |
| (20) | Brontotherium ingens | *Marsh* | Am. Jour. Sci., Jan., 1874, p. 85. |
| (21) | Symborodon hypoceras | *Cope* | Bull. U. S. Geol. Surv. Terr., 1874, p. 491. |
| (22) | Anisacodon montanus | *Marsh* | Am. Jour. Sci., 1875, p. 246. |
| (23) | Diconodon *non* Anisacodon | " | " " 1876, p. 339. |
| (24) | Menodus angustigenis | *Cope* | Ann. Rep. Geol. Surv. Can., Jan., 1896, C., p. 81. |
| (25) | " tichoceras | *Scott & Osborn* | Bull. Mus. Comp. Zoöl., 1887, August, p. 159. |
| (26) | " dolichoceras | " | " " " " p. 160. |
| (27) | " platyceras | " | " " " " " |
| (28) | Brontops robustus | *Marsh* | Am. Jour. Sci., Oct., 1887, p. 326 (Sept. 24th). |
| (29) | " dispar | " | " " " p. 327. |
| (30) | Menops varians | " | " " " p. 328. |
| (31) | Titanops curtus | " | " " " p. 330. |
| (32) | " elatus | " | " " " p. 330. |
| (33) | Allops serotinus | " | " " " p. 331. |
| (34) | Haplacodon angustigenis | *Cope* | Am. Nat., 1889, March, p. 153. (*bis*). |
| (35) | Menodus selwynianus | " | " " July, 1889, p. 628. |
| (36) | " syceras | " | " " " " " |
| (37) | Diploclonus amplus | *Marsh* | Am. Jour. Sci., June 1890, p. 523. |
| (38) | Teleodus avus | " | " " " p. 524. |

In 1860 Prout (10) proposed to make the same specimen the type of a new genus *Leidyotherium*. Leidy soon rectified his mistake, referring this palate to *T. proutii*, but even in his great memoir of 1869 he placed *Titanotherium* in the Anthracotheriidæ. In 1870, still ignorant of the upper skull structure, Leidy (11) described the horns and nasals sent to him from Colorado as *Megacerops coloradensis*, a form which he, in common with Cope and Marsh, believed to be related to the Dinocerata.

Between 1870 and 1873 the explorations of Marsh and Cope in Colorado yielded a series of skulls and limbs, and established these animals definitely as a distinct family of Perissodactyla (see Marsh, Am. Jour. Sci., June, 1873). Marsh (12) founded his first species upon a jaw and dentition, also from Colorado, to which he gave the name *Brontotherium gigas*. He distinguished the genus from Leidy's *Titanotherium* by the presence of but *three* lower premolars. We have seen, however, that Leidy's generic type only contained the four back teeth, P4 to M3, and we now know that the number of lower premolars is subject to individual variation, for some animals have three premolars upon one side and four upon the other side of the jaw. The generic distinction is therefore invalid, while the species *T. gigas*, although founded upon a fine jaw, awaits correlation with a skull before it can be defined. We are indebted to Marsh for the first complete outline of the main characters of the family, in his article of 1873 'On the Structure and Affinities of the Brontotheriidæ."[1] Shortly after *Brontotherium* was proposed, Cope (13) (Aug., 1873) proposed[2] a fourth genus, *Symborodon*, selecting as types "mandibular rami only, which cannot be certainly associated with crania," and distinguishing the genus by the supposed absence of lower incisors and by the presence of but three lower premolars. With his type species *S. torvus* (13) were found three other species, in which he did not at first recognize the Titanothere kinship, namely : *Miobasileus ophryas* (14), *Megaceratops acer* (15), *Megaceratops heloceras* (16). The first named, *M. ophryas*, was established upon a cranium, and proposed as the type of a fifth genus, *Miobasileus*, since abandoned by Cope. In October, 1873,[3]

[1] Am. Jour. Sci. and Arts, 1873, p. 486.
[2] Pal. Bull. No. 15, Proc. Am. Phil. Soc., August 20, 1873, p. 2.
[3] Synopsis of New Vertebrata from the Tertiary of Colorado (*S. ophryas*), Oct., 1873.

Cope referred to *Symborodon* all the preceding as well as the additional species ; (17) *S. bucco*, as the largest type of the genus ; (18) *S. altirostris*, distinguished by the elevated position of the snout and horns ; *S. trigonoceras* (19), distinguished by the short, stout, triquetrous horns.

In January,[1] 1874, Marsh (20) gave the full account of the family above referred to, and proposed the species *Brontotherium ingens* upon a nearly complete skull and jaws. In July, 1874, Cope's 'Report upon the Vertebrate Palæontology of Colorado"[2] contained a full description of the chief characteristics of the family and an analysis of all the species of *Symborodon*, together with the definition of the new species *S. hypoceras*.[3]

All the above specimens, excepting Leidy's original generic type jaws, were found in the Oligocene of Colorado. In 1875[4] Marsh described his collections of 1874 in Dakota and Nebraska and proposed the sixth new genus *Anisacodon* (22), distinguished by three lower premolars and the last upper molar with two cones, the type species *A. montanus* (22) being a skull from Nebraska. In April, 1876, this was re-named *Diconodon*; (23) the principal characters of the family were again discussed, and the types of *B. gigas*, *B. ingens* were figured.[5] In 1886 Cope described the *M. angustigenis* (24) from Canada. Thus the matter rested until August, 1887, when Scott and Osborn[6] reviewed the family and described the collection made for the Harvard University Museum by Garman in Dakota. They revived the term *Menodus* and proposed the new species: *M. tichoceras* (25), *M. dolichoceras* (26), and *M. platyceras* (27), accompanied by a restoration of *M. proutii*. In the meantime Hatcher had brought together for the U. S. Geological Survey a remarkable series from Dakota and Nebraska, which together with skulls from Colorado formed the basis of a further contribution from Marsh.[7] He proposed first the genus *Brontops*, from the type species, *B. robustus*, from northern Nebraska, and the smaller species *B. dispar* from Dakota ; second, the genus *Menops*, from the type, *M. varians*, and the genus *Tita-*

[1] Am. Jour. Sci., Jan., 1874, p. 6.
[2] Bull. U. S. Geol. Surv. Terr., 1873 (publ. 1874), pp. 427–533.
[3] Op. cit., p. 491.
[4] Am. Jour. Sci., March, 1875, p. 245.
[5] Am. Jour. Sci., 1876, p. 335.
[6] Bull. Mus. Comp. Zoöl., Vol. XIII, 1887, p. 157.
[7] Am. Jour. Sci., Oct., 1887, pp. 326–331.

*nops* from the type skull of *T. curtus* found in Colorado, and a second species *T. elatus*, from Dakota; fourth, the genus *Allops*, from the type skull *A. serotinus* found in Dakota.

In 1889 Cope proposed the genus *Haplacodon* (34) from his Canadian Survey species, *M. angustigenis*,[1] and added the two additional species *M. selwynianus* (35) and *M. syceras* (36). His latest additions are found in his report[2] from the Oligocene of the Cypress Hills, Canada, in which he further characterizes the three new species above referred to.

The latest genus to be added to the long series is *Teleodus* (37), characterized by Marsh[3] as having *three* lower incisors, and believed by Hatcher to come from the lowest beds, also to possess a trapezium.

It is obvious that the only method of clearing up this heterogeneous list is first to establish certain laws of cranial development, and second, to apply these laws to the distinction of the genera and species in chronological order. Examined in this way, the vast array of genera and species are resolved into one or possibly two genera, and about fourteen definable species.

## II.—Principles of Cranial and Dental Evolution.

The main characters hitherto used in definition by Marsh and Cope, Scott and Osborn, are :

*A.* Number of incisors and of premolars. (Cope, Marsh.)

*B.* Development of a cingulum upon the premolars. (Cope, Marsh.)

*C.* Presence of a second cone upon last superior molar. (Marsh.)

*D.* Length and shape of nasals. (Cope, Marsh, Scott, Osborn.)

*E.* Length and shape of horns. (Cope, Marsh, Scott, Osborn.)

*F.* Presence or absence of a trapezium. (Hatcher.)

[1] Am. Nat., 1889, p. 628.
[2] Contr. to Canadian Palæontology, Vol. III, p. 9.
[3] Am. Jour. Sci., June, 1890, p. 524.

The principles of cranial evolution which put these characters to the test and determine which are valid and which invalid, may be considered under ten heads: 1. General increase of size. 2. Dental series as a whole. 3. Horns. 4. Nasals. 5. Zygomatic arches. 6. Auditory meatus. 7. Cingula. 8. Incisors. 9. Canines. 10. Hypocone.

## 1. *General Development in Ascending Geological Levels.*

| Progressive. | Retrogressive. |
|---|---|
| 1. General increase in size of skull and skeleton. | 2. Dental series relatively arrested or retrogressive in development. |
| 3. Horns elongating in males.<br>*a*. Shifting forwards to absorb nasals.<br>*b*. Long axis altering from antero-posterior to transverse plane.<br>*c*. Acquiring a transverse connecting crest, uniting them at the base. | 4. Nasals degenerating in both sexes to reduced knobs. No sexual differences apparent. |
| | 9. Trapezium disappearing at an early period. |
| 5. Zygomatic arches spreading. | 8. Incisors becoming variable at an early period, especially in females. |
| 6. Post-glenoid and post-tympanic processes uniting. | 7. Premolar cingula reduced in latest stages. |
| 6*a*. Occiput broadening and becoming more robust; superior border becoming deeply concave. | 7*a*. First lower premolar becoming variable. |
| 12. Third trochanter developing.[1] | |

## 2. *Growth and Age Characters common to both Sexes and all Geological Levels.*

1. Increasing rugosity of the skull, arches, horns and nasals.
8. Loss of variable and vestigial teeth, incisors and premolars in old age.
11. Anterior caudal[2] uniting with sacrum to form four sacrals.

[1] Teste Hatcher, Am. Nat., March, 1893, p. 216.
[2] Teste Hatcher, Am. Nat., March, 1893, p. 217.

TABLE II.—MEASUREMENTS OF SKULLS AND TEETH.

| | Catalogue Number of Specimen. | Length of Skull. | | Width across Zygomatic arches. | Length of Molar-Premolar Series. | | Occiput.[1] | | Horns.[2] | | Nasals.[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Condyle to tip of Premax. | Occiput to tip of Nasals. | | $p^1$–$m^3$. | $p^{1-4}$ | Height. | Breadth | Length. | Spread. | Free Length. |
| T. heloceras | 6360 | .637 | .652 | .393 | .287 | ... | .175 | .169 | .126 | .280 | |
| T. trigonoceras, Type | 6355 | .... | .765 | .485 | .... | .... | .172 | .266 | .145 | .348 | .141 |
| T. trigonoceras | 6356 | ... | ... | .. | .354 | .130 | ... | .... | .150 | .358 | .130 |
| T. trigonoceras | 501 | .675 | .705 | .452 | .314 | .125 | .225 | .278 | .130 | .280 | .100 |
| T. trigonoceras | 1445 | .680 | .680 | .470 | .345 | .135 | .222 | .276 | .111 | .280 | .100 |
| T. ingens, Type | .... | .... | .915[4] | .558 | .428 | .162 | .... | .... | .... | .507 | |
| T. ingens ♂ | 505 | .805 | .780 | .546 | .398 | .150 | .247 | .325 | .192 | .494 | .126 |
| T. ingens ♂ | 1066 | .770 | .830 | .550 | .365 | .135 | .225 | .335 | .183 | .435 | .122 |
| T. ingens ♀ | 1067 | .730 | .820 | .440 | .355 | .140 | .265 | .260 | .214 | .480 | .127 |
| T. ingens ♀ | 506 | .805 | .770 | .... | .410 | .151 | .... | .... | .175 | ... | .135 |
| T. (bucco) torvum | 6345 | .665 | .813 | .660 | .291 | .... | .225 | .330 | ?.210 | ?.361 | .090 |
| T. (bucco) torvum | 6346 | .... | .... | .670 | .... | .... | .300 | .325 | | | |
| T. robustum ♂ | 1083 | .758 | .... | .600 | .365 | .141 | .... | .... | .150 | .355 | .090 |
| T. robustum ? ♂ | 1069 | .833 | .830 | .645 | .380 | .145 | .390 | .170 | .130 | .324 | .096 |
| T. robustum | 1082 | .767 | .835 | .652 | .355 | .132 | .235 | .355 | .178 | .378 | ?.085 |
| T. robustum ♀ | 518 | .825 | .835 | .557 | .408 | .165 | .240 | .356 | .110 | .300 | .075 |
| T. torvum (robustum) | 1081 | .707 | .767 | .610 | .367 | .139 | .250 | .320 | .231 | .307 | .066 |
| T. dolichoceras | 520 | .720 | .850 | .565 | .330 | .132 | .215 | .345 | .145[1] | .422[1] | .068 |
| T. elatum ♂ | 492 | .880 | .930 | .737 | .362 | .125 | .285 | .440 | .361 | .566 | .100 |
| T. elatum ♂ | 1070 | .... | .... | .... | ... | .132 | .... | .... | .240 | .418 | .090 |
| T. elatum ♀ | 1005 | .690 | .673 | .540 | .346 | .135 | .203 | .292 | .142 | .287 | .047 |
| T. elatum ♀ | 1006 | .720 | .740 | .490 | .335 | .126 | .265 | .300 | .155 | .290 | .073 |
| T. amplum (elatum) ♀ | 1008 | .735 | .781 | .495 | .365 / .340 | .... | .... | .... | .233 | .340 | .040 |
| T. acer ♂, Type | 6348 | .... | .680 | .... | .... | .... | .235 | .... | .290 | .350 | .061 |
| T. (altirostris) acer ♀ | 6350 | .634 | .645 | .... | ?.330 | ... | .245 | .... | ?.141 | | |
| T. acer ♀ | 6349 | .635 | .655 | .... | .335 | .130 | .235 | .185 | .178 | .290 | .050 |
| T. ramosum ♂, Type | 1447 | .742 | .820 | .774 | .360 | .131 | .250 | .400 | .399 | .635 | .049 |
| T. platyceras ♂ | 1448 | .730 | .858 | .815 | .342 | .123 | .280 | .455 | .433 | .620 | .019 |

[1] In several cases these measurements are approximate, owing to crushing.
[2] This measurement is taken down the outer side of the horn to the anterior nares.
[3] This is the free portion of the nasals as seen in profile.
[4] Lineal measurement taken from condyle to tips of nasals.

3. *Sexual Characters, common in all Species, especially in the Higher Geological Levels.*

| Male. | Female. |
|---|---|
| 1. Skulls of greater dimensions. | 1. Skulls of smaller size. |
| 3. Horns, especially in upper beds, very long and powerful. | 3. Horns shorter, often imperfectly ossified at the tips. |
| 3*a*. Transverse connecting crest very prominent in higher levels. | 3*a*. Transverse crest somewhat less prominent. |
| 5. Zygomatic arches widely extended into buccal plates. | 5. Zygomatic arches less widely expanded. |
| 1. Occiput with stout lateral pillars and broad rugose upper border (in upper beds). | 1. Occiput less robust. |
| 9. Canines robust. | 9. Canines smaller, pointed. |
| 8. Incisors larger and more constant. | 8. Incisors more variable, smaller. |

Hatcher[1] has placed 'delicate nasals' and a 'feebler internal cingulum' upon the premolars among the female characteristics. Our observations do not confirm this; these structures are apparently independent of sex.

4. *Individual variations observed in members of the same sex and species.*

8. Incisors sometimes constant, sometimes entirely wanting or unequal in number upon opposite sides of the skull, varying from 2 to 1 to 0.
7. Premolar 1 variable, sometimes present upon one side and wanting upon the other side of the jaw.
10. Second internal cone upon last superior molar inconstant in members of the same species.
7. Internal cingulum upon premolars variable.

A comparison of the figures upon Plates III and IV shows the rapid increase in size. The Titanothere skull development in general is marked (*a*) by the forward movement of the orbit; (*b*) the great backward elongation of the skull and temporal fossæ; (*c*) in the occiput the deep excavation of the superior border, the development of lateral pillars, and of the superior rugose crest; (*d*) closure of the external auditory meatus inferiorly.

[1] Am. Nat., March, 1893, p. 216.

5. *Influences of Age, Sex, Growth and Variability.*

1°. General laws of growth.—In the accompanying Table II the species are arranged approximately in the order of evolution, taking *T. heloceras* as the least specialized and *T. platyceras* as the most specialized types.

The skull gains only 10 or 20 centimeters in *length*, while it doubles in *width*, gaining 400 centimeters.

The premolar-molar series rapidly increases in length, and then as rapidly diminishes, so that the grinding area is no larger in the very large animals (*T. platyceras*) of the upper beds than in the small animals (*T. trigonoceras*) of the lower beds.

The occiput gains about 10 centimeters in height and nearly 30 in breadth.

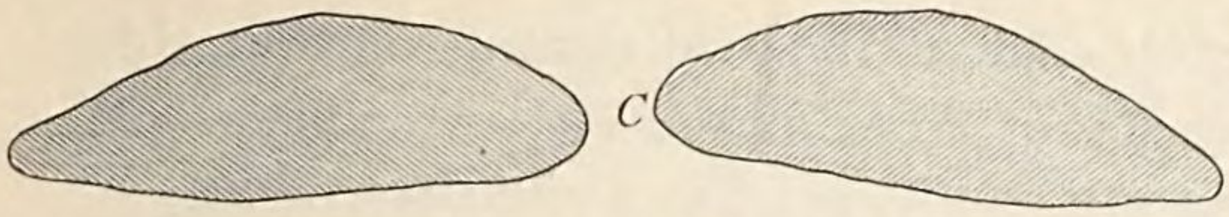
The horns increase to three or four times their original length while the nasals diminish to one-sixth their original length.

2°. Arrested growth of the teeth.—1 & 2. The general increase in the size of the skull and body is not accompanied by a corresponding increase in the dental series. Table II shows that the premolar-molar series reach their maximum in the characteristic species of the middle beds, namely, *T. ingens*, and then actually decline, so that in the enormous animals of the highest beds the dental series has relatively less volume than in the comparatively small creatures of the lower beds. This arrested tooth development may have been a factor in extinction. An exactly analogous fact is observed in the Dinocerata.

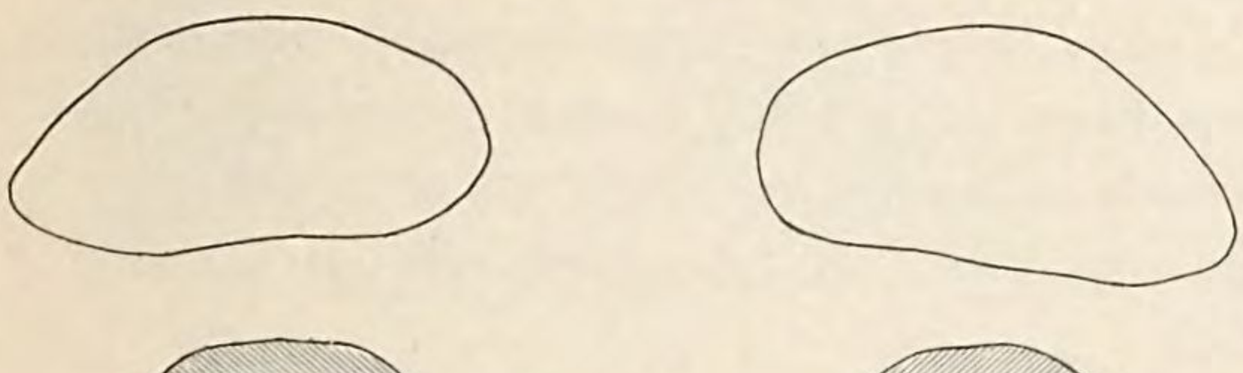
3°. Horns. The whole skull structure is mainly secondary to the horns. The successive stages in the form and position of the horns are therefore highly characteristic.

*1st Stage.*—In *Telmatotherium*[1] and *Diplacodon*[2] they arise at the junction of the fronto-nasal suture, slightly in front of the orbits, overhanging the sides of the face. The primitive horn section is therefore an *antero-posterior oval*, and the longest diameter of all of the earliest horn types is parallel with the long axis

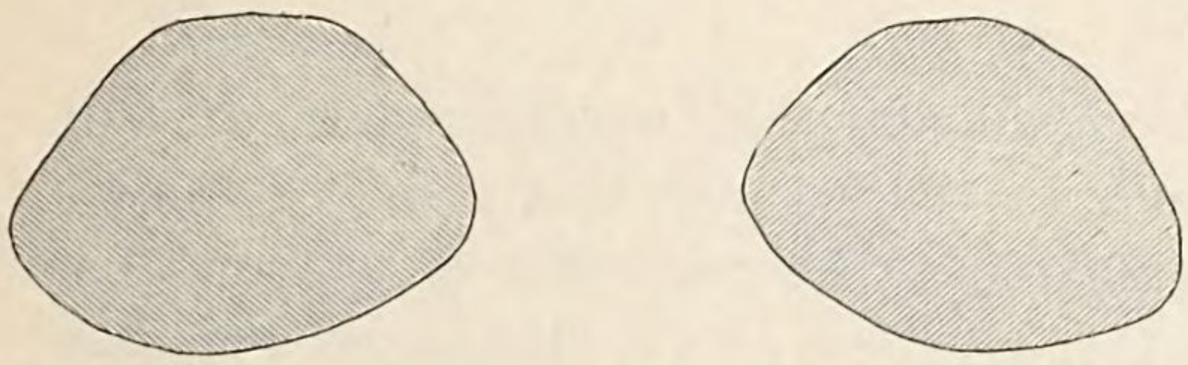
[1] Osborn, 'Fossil Mammals of the Uinta Basin.' Bull. Am. Mus. Nat. Hist., 1895. p. 91.
[2] Hatcher 'On a New Species of Diplacodon,' Am. Nat., 1895, Pl. XXXVII.



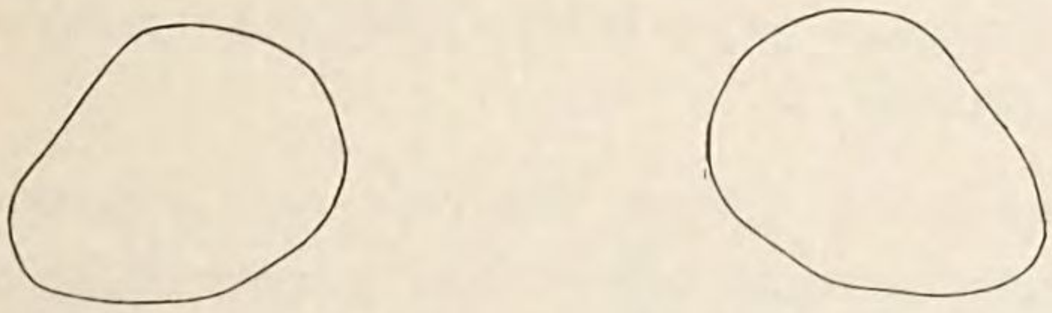

. . *Titanotherium platyceras.*
(No. 1448.)



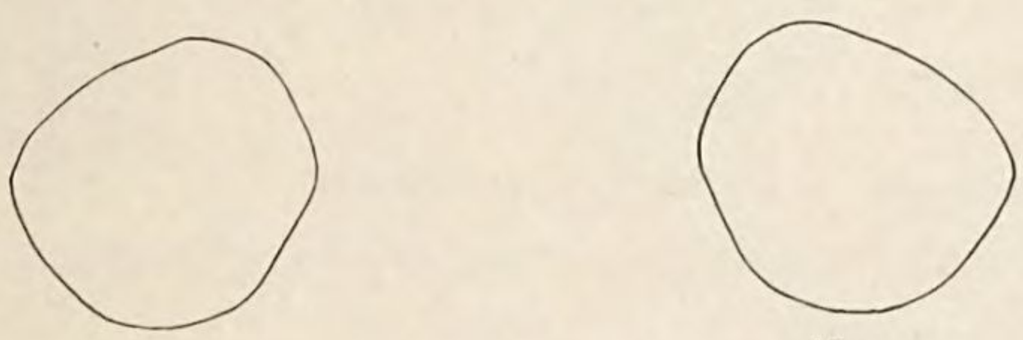
. . *Titanotherium ramosum.*
(No. 1447.)



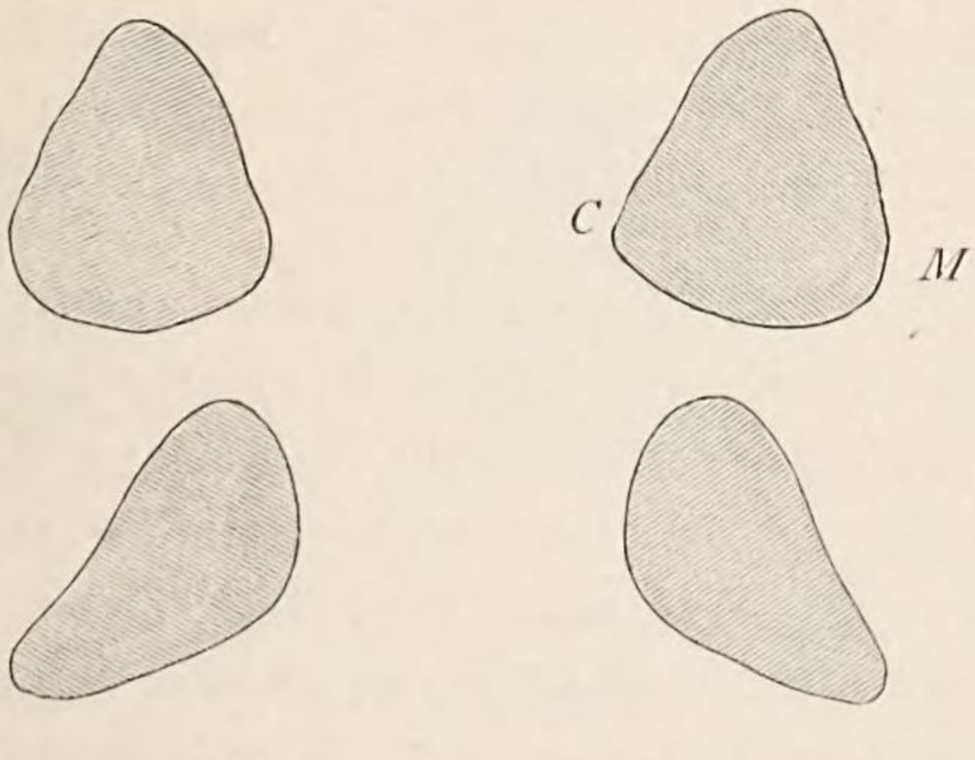
. . *Titanotherium elatum.*
(No. 492.)



. . *Titanotherium robustum.*
(No. 1083.)

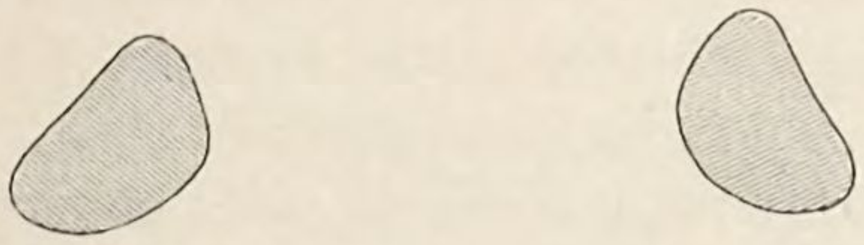


. . *Titanotherium bucco.*
(No. 6345.)




. . *Titanotherium trigonoceras.*
(No. 6355.)

. . *Titanotherium trigonoceras.*
(No. 501.)



. . *Titanotherium heloceras.*
(No. 6360.)

DIAGRAM I.—Horn sections taken just above the base, showing the development from an antero-posterior to a transverse axis. *N*, line connecting with nasals. *M*, line descending to malars. *C*, line entering connecting crest. The anterior face of the horns is above.

of the skull; the anterior edge of the oval extends into the sides of the nasals *N*, the posterior edge dips back to the malars *M*. At the close of this stage the horns acquire a *circular section.*

*2d Stage.*—A low 'connecting crest' arises between the bases of the horns and gives them a *trilateral section* consisting of an antero-median face, a postero-median face, and an antero-inferior face. Thus all middle horn types are triangular, with an internal angle *C*.

*3d Stage.*—The horns gradually shift forwards until they directly overhang the anterior nares, and finally the symphysis. They thus *absorb* the nasals and lose their base of support upon the greatly abbreviated maxillaries. Thus disappears the nasal angle *N*; also the antero-inferior or maxillary face, and the horns acquire a *transverse oval* section.

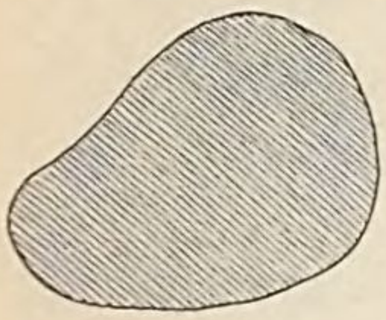
*4th Stage.*—While the horns flatten, the web, or '*connecting crest*,' between their bases, increases until the horns consist of two recurved plates connected by a broad median crest. This is the final stage, consisting of a "*disc section.*"

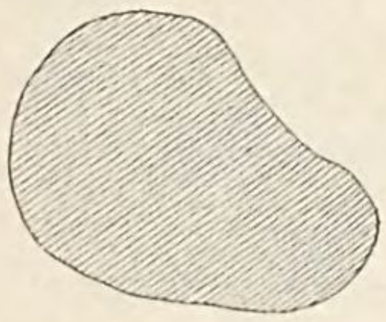
There is thus a total change in form and position.

The ontogeny of the horns recapitulates the phylogeny more or less closely in the lower beds only.

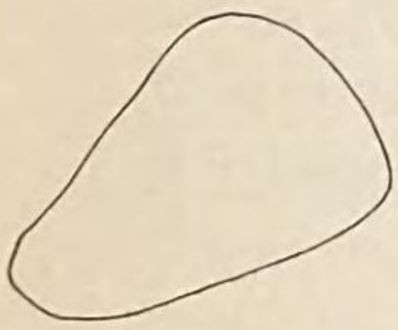
Both Marsh and Hatcher have remarked that females are distinguished by smaller horns. But Marsh has not applied this principle in his definitions. The sexual distinctions are as follows:

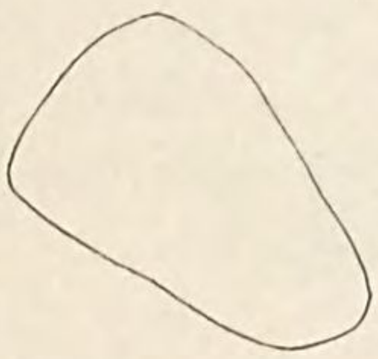
*Female Horns.*—In *female* Titanotheres the horns exhibit an *arrested stage of male development.* This is most clearly demonstrated in the comparison of three female skulls (Nos. 1005, 1006, 1008) in the American Museum Collection, with two male skulls (Nos. 492, 1070) of the species *T. elatum.* (See Figs. 9, 10, 11.) In the females the horns are often imperfectly ossified at the tips, sometimes pointed. As the horns evolve in the higher levels the differences between the sexes become more marked, for we observe less wide contrasts in skulls found in the lower beds. As seen in *T. acer*, *T. trigonoceras* and *T. ingens*, the 'connecting crest' is more constant and more pronounced in males than in females.



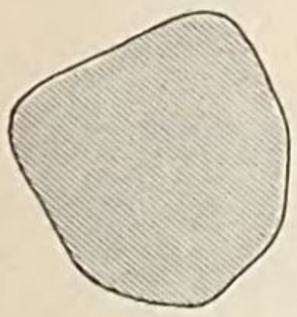


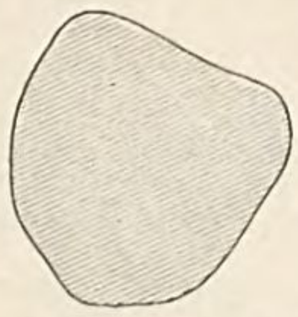
. . *Titanotherium dolichoceras.* Type.



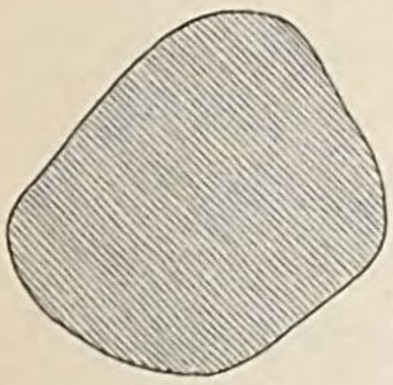


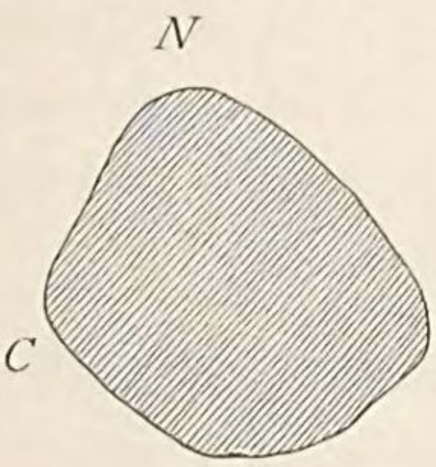
. . *Titanotherium? serotinus.* (No. 520.)





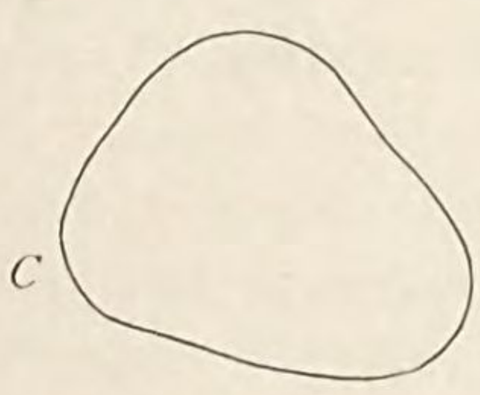
. . *Titanotherium acer.* (No. 6348.)






. . *Titanotherium tichoceras.* Type.






. . *Titanotherium ingens.* (No. 505.)

DIAGRAM II.—Horn section taken in the same manner as Diagram I.

Again, among the skulls referred to *T. ingens* (505, 1066, 1067), three have very stout triangular horns, a fourth (506), although a very large animal, has more slender horns, rounder in section, with very slender canines. This is believed to be a female. Similar differences are observed in specimens of *T. trigonoceras.*

*Individual Variations.*—The appearance of the horns is greatly affected by the stages of growth and by the crushing. There are two cases of *branching* in this collection, a feature considered by Marsh a generic character in his type of *T.* (*Diploclonus*) *amplus.* One case is in the horns of a female of *T. elatum* (1008), another is in an undetermined skull (1081). This character is apparently an individual variation.

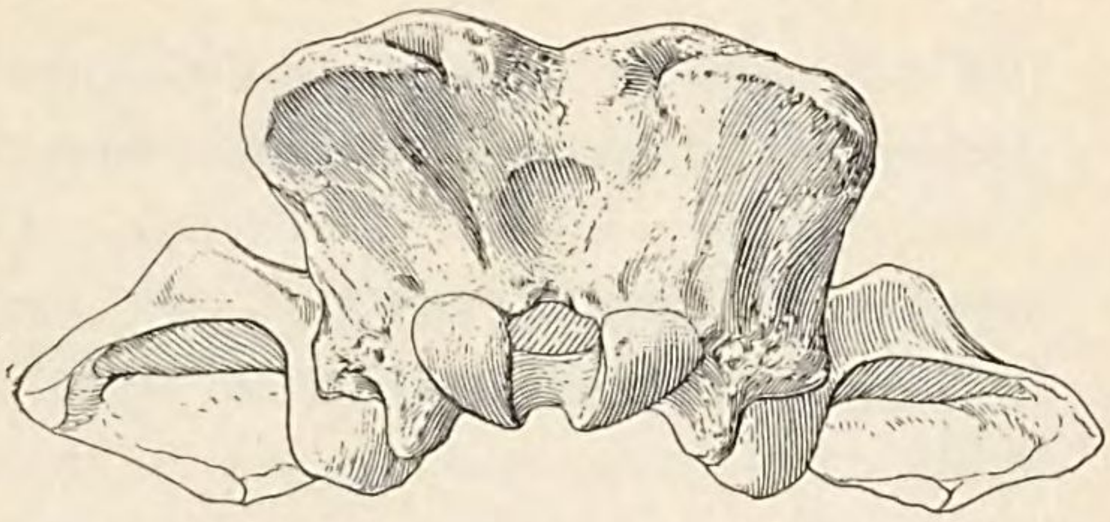
4°. Nasals.—The hypertrophy of horns and compensating atrophy of nasals was pointed out by the writer in 1887. It now appears more accurate to state that the horns practically shift forward to the tips of the nasals.

The length and form of the nasals is a characteristic feature of progressive development, and is very slightly if at all subject to sexual variation as believed by Hatcher[1]. In the primitive condition[2] (*Diplacodon*) the nasals are long, and distally broad and truncate. In *T. coloradense* Leidy they taper and are recurved distally. In the *T. trigonoceras* and *T. ingens* skulls they are broad, rugose and often cleft distally. In progressive development they are rapidly reduced in length and tapered so that they finally become short-pointed knobs.

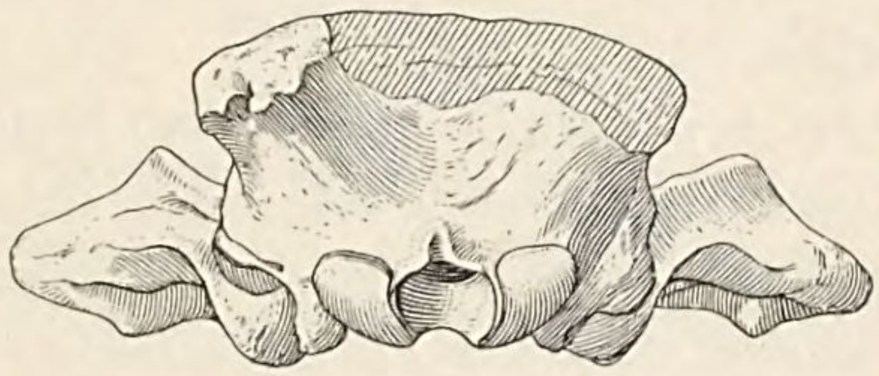
5°. Zygomatic Arches.—There is considerable but not absolutely conclusive evidence that the very robust widely spreading zygomatic arches of the latest species are *male* characteristics. In the *T. elatum* series all the skulls with feeble or imperfect horns and small canines have moderately expanded arches, while the old male (No. 492) has enormous cheek bones. In the *T. ingens* series the same difference is observed in a less marked degree. If this character is actually sexual, it is one in which (as in the horns) the males progressively diverged from the females in the evolution of the skull.

[1] Am. Nat., March, 1893, p. 216.
[2] Hatcher. *op. cit.*, Pl. XXXVII.

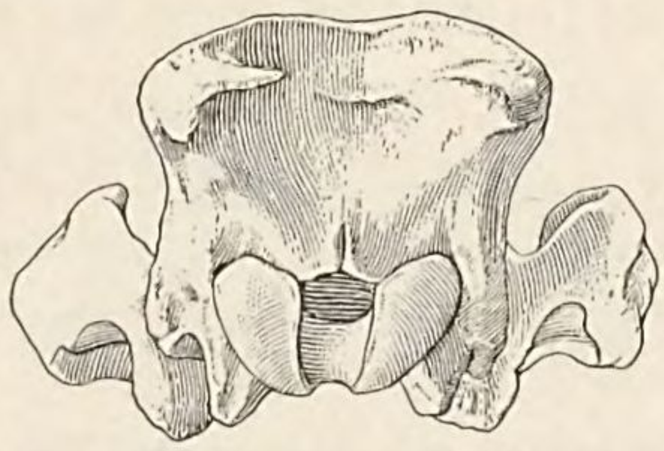
*Titanotherium elatum* . . . . . .
(No. 492.)



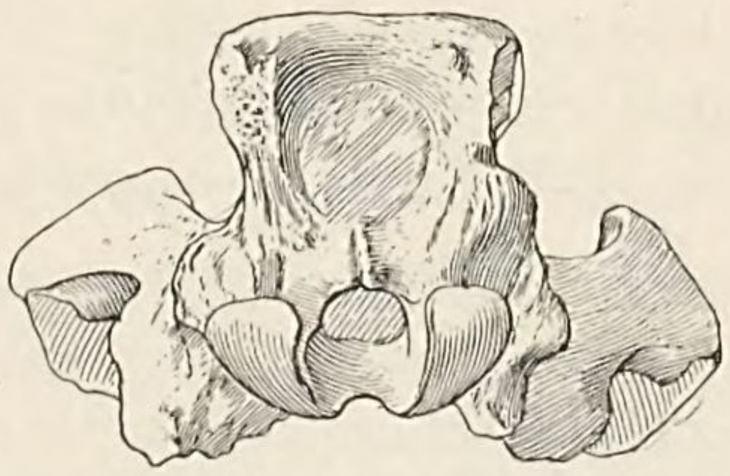
*Titanotherium bucco*. . .. . .
(No. 6345.)



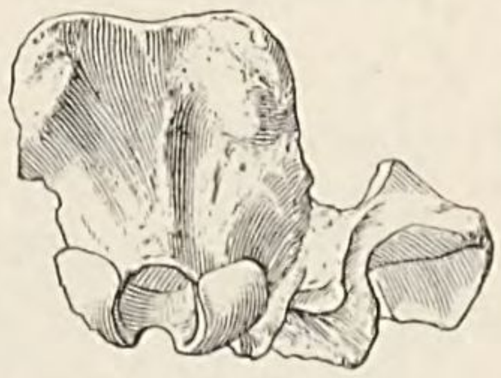
*Titanotherium ingens* ♀ . . . . . .
(No. 1067.)



*Titanotherium coloradense* . . . . . .
(Harv. Univ. Mus.)



*Titanotherium acer* . . . . . .
(No. 6348.)



*Titanotherium heloceras* . . . . . .
(No. 6360.)

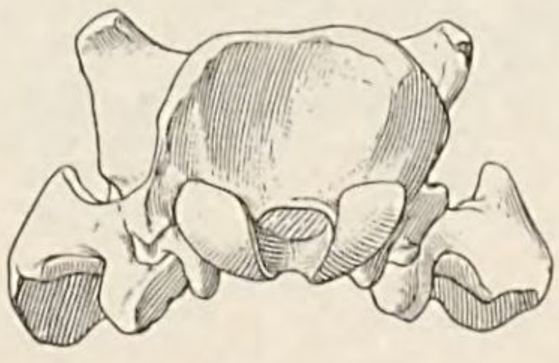


Fig. 1. Exhibiting the evolution of the occiput, the lateral pillars, and incurving of the superior border. One-twelfth natural size.

6°. Auditory Meatus.—The union of the post-glenoid and post-tympanic processes parallels that which we observe in the Rhinoceroses. In the *T. heloceras* skull the external auditory meatus is widely open below. In the *T. platyceras* skull it is reduced to a small foramen enclosed by a solid wall of bone below.

7°. Cingulum.—The cingula are, upon the whole, retrogressive. They reach their greatest development in *T. ingens*, and then decline.

Our materials do not support Hatcher's[1] supposition that strong cingula are characteristic of male skulls, but prove that the development of the *cingulum is irrespective of sex, partly a matter of individual variation, chiefly of robust dentition.*

It follows that Cope[2] is in error in relying upon the cingulum to divide the Titanotheres into two parallel groups.

*Variability.*—In two closely similar skulls (Nos. 501, 1445) the internal premolar cingulum is strongly developed, while the external cingulum is feeble in the one (1445) and strong in the other (501).

*Independent of Sex.*—In the female skull of *T. ingens* (No. 506), the cingula are quite as strongly marked as in the male skulls (Nos. 505, 1066, 1067). In the female skulls of *T. elatum* (Nos. 1005, 1006) the cingulum is as strong or stronger than in the male skulls (Nos. 492, 1070).

*Associated with robust dentition.*—The only forms in which sharply-defined internal and external cingula upon both upper and lower premolars seem to be characteristic, are the type skull and the American Museum skulls of *T. trigonoceras* and *T. ingens.* As shown by the measurements, this species is characterized by a very robust dentition.

*Retrogression.*—A comparison of all the earlier with the later types shows that the cingulum reaches its maximum with the species or the middle beds, and then declines. It is variable in *T. robustum* and almost obsolete in *T. acer* and *T. platyceras.*

[1] Am. Nat., March, 1893, p. 216.
[2] Contr. to Canadian Palæontology, Vol. III, 1891, p. 9.

8°. INCISORS.—Individual variability here is very marked, but there seem to be certain underlying principles, such as the following:

*Persistence.*—So far as the American Museum material is concerned, there is no evidence that the incisors are positively retrogressive, as commonly stated by Hatcher and others, since three heavily horned male skulls of *T. platyceras* and of *T. elatum*, from the topmost strata, present two pairs of full-sized incisors. Marsh[1] also implies that his long-horned specimens (*Titanops*) have two upper incisors.

On the other hand, one of the most primitive skulls (No. 501) of *T. coloradense* presents but one incisor upon each side, and all the skulls in the middle beds (*T. ingens*) of our collection exhibit no incisors at all.

*Sex.*—Of the supposed females of *T. elatum*, one (1005) has no upper incisors, one (1006) has reduced vestiges of the lateral pair, two (1008, 520) have the outer pair well developed. Marsh's type is said to have two upper incisors. It would appear from this that in this species at least the incisors are more variable and reduced in females than in males.

This evidence is offset by the fact that in all the five, *T. trigonoceras*, *T. ingens* skulls the incisors are vestigial or wanting without distinction of sex. Marsh figures two incisors in dotted outlines, but his type of *T. ingens* entirely lacks the premaxillaries, and therefore gives no evidence. It would appear, however, that in *T. trigonoceras* the incisors are vestigial or wanting in both sexes and in both jaws.

9°. CANINES.—We here derive characters both of sexual and of specific value.

*Sex.*—The shape of the canines is the same in both sexes, but the male tusks are much more powerful than the female. This is especially marked in the male *T. ingens* (No. 505), in which the tusks are 62 mm. long by 34 mm. diameter at the cingulum, while in the female (No. 506) the canines measure only 40 x 21 mm.

It is also well shown in *T. elatum* in which the female tusks are also two-thirds the size of the male tusks, as observed in a com-

[1] Am. Jour. Sci., Oct., 1887.

parison of five skulls. In the latest types of males the canines are powerful but obtuse.

10°. Second internal cone of last upper molar.—Individual variability here reaches its maximum. This cone, which is well known to occur in the *Palæosyopinæ* of the Bridger, is apparently neither a specific nor progressive character in *Titanotherium*. It is found in all stages of independence from the cingulum in the oldest as well as in the most recent types. It certainly varies within the limits of a single species and sex.

### 6. *General Conclusions.*

The net result of this examination is that the characters upon which the genera *Symborodon*, *Diconodon*, *Brontops*, *Titanops*, *Allops*, *Haplacodon* and *Diploclonus* are founded, are either marks of sex, age or individual variability, and that these names have no standing whatever. *Teleodus* may prove to be a distinct form, but has not yet been separated generically from *Diplacodon*.

## II.—Revision and Definition of Species.

For Dates, see Table I.

### Menodus *Pomel.*

Preoccupied by *Menodon*, von Meyer.

### 3. Titanotherium proutii *Leidy.*

Indeterminate species.

### 4. Titanotherium bairdii *Leidy.*

Indeterminate species.

### 5. Titanotherium giganteum *Leidy.*

Indeterminate species.

### 6. Titanotherium americanum *Leidy.*

Indeterminate species.

### 8. Titanotherium maximum *Leidy.*

Indeterminate species.

## 11. Titanotherium coloradense *Leidy.*

PLATE III.

*Megacerops coloradensis* LEIDY. (Type of genus *Megacerops.*)

*Type Loc* —Colorado. Level unknown.

*Type.*—Fractured horns and nasals. Coll. Acad. Nat. Sciences, Phila.

*Spec. Char.* (of Type).—*Horns* of medium length; section antero-posterior oval or slightly trihedral at base, rounded at summit; directed upwards and outwards; no transverse crest. *Nasals* long, tapering somewhat, decurved and notched at extremity.

The full characters of this species are not certainly known. In the Harvard University Museum is a complete skull in which the corresponding parts are closely but not exactly similar in form and measurement to Leidy's type. This skull,[1] apparently female, exhibits the following characters:

Cranium long and narrow; occiput elevated and slender, narrow, with superior border not incurved; zygomatic arches expanding slightly; external cingulum feeble upon $P^{1-3}$, strong upon $P^{4}$, post-glenoid and post-tympanic processes not quite in contact; one superior incisor.

A closely related, if not identical form, is the Canadian Survey specimen, referred to *T. americanum* by Cope.[2]

## 12. Titanotherium gigas (*Marsh*).

*Brontotherium gigas* MARSH. (Type of genus *Brontotherium.*)

*Type Loc.*—Colorado. Level not ascertained.

*Type.*—"Lower jaws and entire molar series complete." Yale Univ. Mus.

This species and genus were defined by the presence of *two* lower incisors, while the lower jaw exhibits but *three* premolars on each side. It has an evenly-arched lower border and shallow chin. It remains *indeterminate* until the skull characters become known.

---

[1] It has unfortunately been injured since it was described and figured by Scott and Osborn, Bull. Mus. Comp. Zoöl., 1887, p. 158.

[2] Contr. Can. Pal., Vol. III, p. 10, Pl. vi, fig. 1.

## 13. Titanotherium torvum (Cope).

PLATE III.

*Symborodon torvus* COPE. (Type of genus *Symborodon.*)

SYN. *Symborodon bucco* COPE.

*Type Loc.*—Colorado. Level not ascertained.

*Type.*—Complete lower jaws. Coll Am. Mus. Nat. Hist., No. 6365.

*Spec. Char.—Horns* short, above narial opening, ? sub-circular in section; directed forwards, upwards and outwards; no connecting crest. *Nasals* of medium length, notched distally. Zygomatic arches widely projecting with a rounded outer section, slightly flattened vertically. Occiput low, deeply excavated, heavy outer pillars. External premolar cingula reduced or wanting. Dentition : $\frac{2}{0}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{3}{3}$.

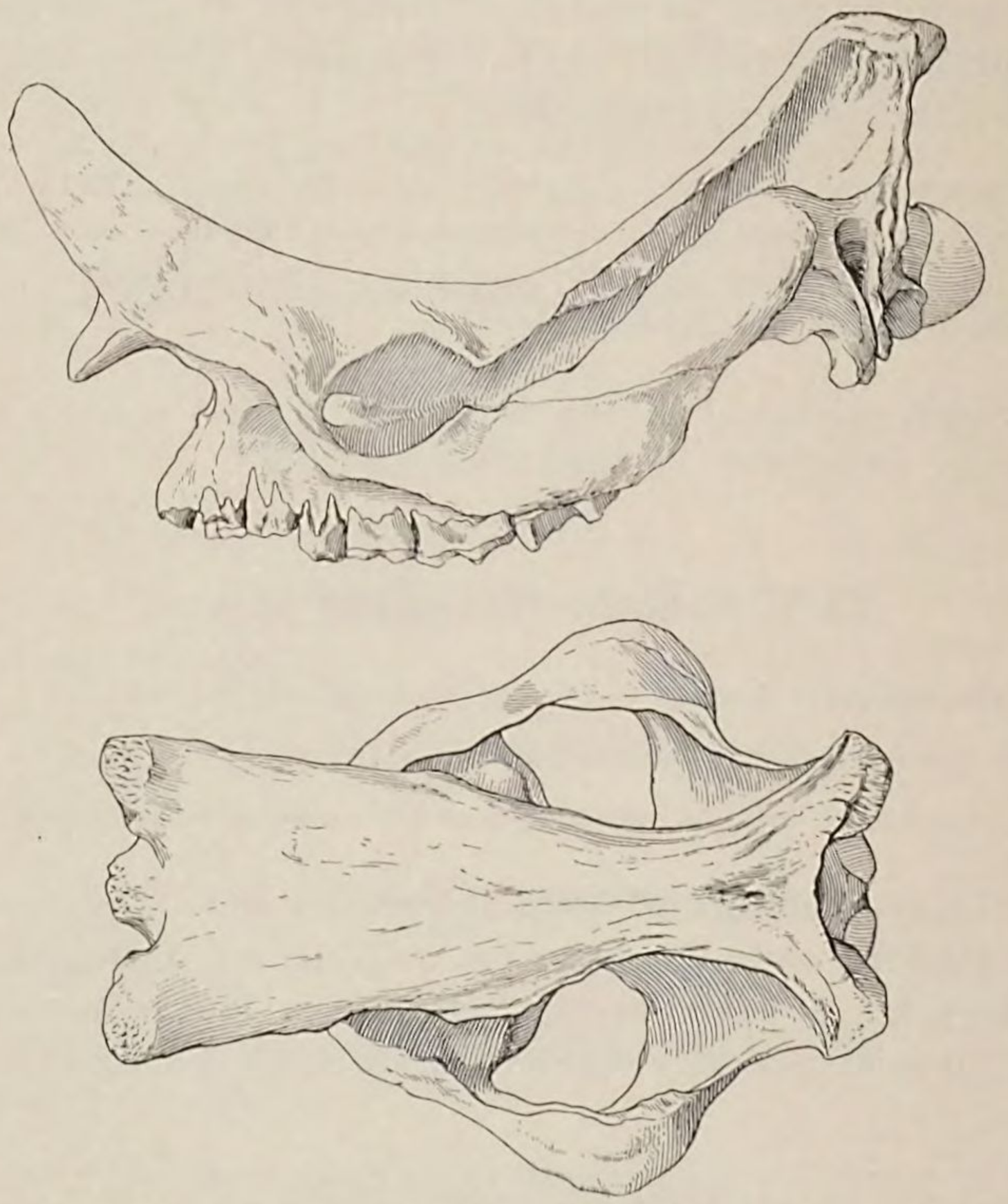


Fig. 2. *Titanotherium torvum* (or *robustum*). Skull (No. 1081) in lateral and superior views. The *nasals* are partly restored.

The type jaw entirely lacks the lower incisors and presents only three premolars upon each side. The premolars exhibit incomplete external cingula. As observed by Cope, it agrees precisely with the lower jaw of Cope's type of *Symborodon bucco* (No. 6345, Am. Mus., Cope Coll.), and it is by combining these two types that we obtain the specific characters given above.

Unfortunately in Cope's type of *S. bucco*, from which all the skull characters in the above definition are derived, the horns and nasals, although present, are very imperfectly preserved. This

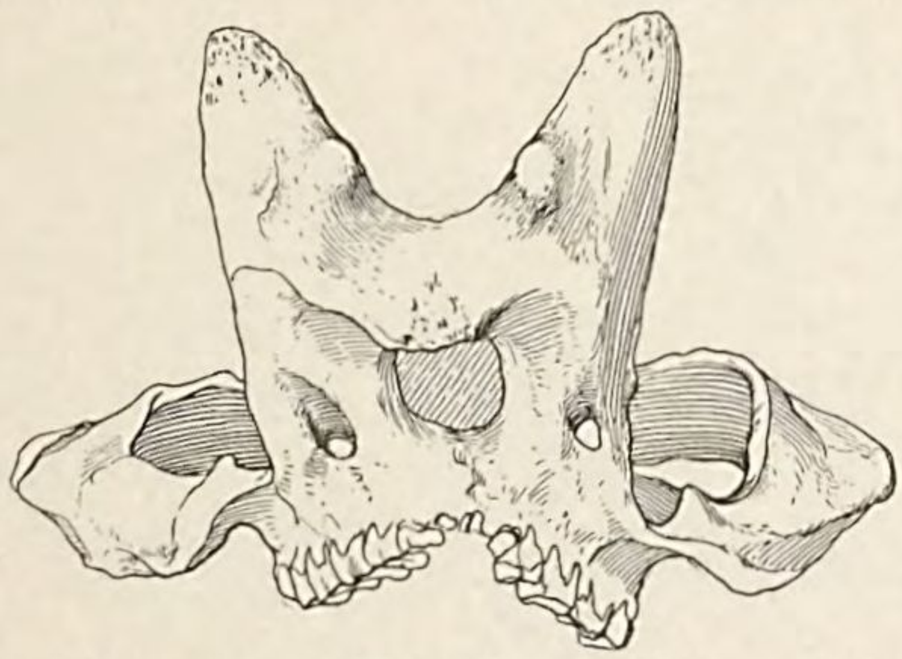


Fig. 3. *Titanotherium torvum* (or *robustum*). Skull (No. 1081) in front view, exhibiting the *branching* of the horns.

makes it impossible to exactly define this species, or determine its sex. The premaxillæ have been lost, so that it is impossible to verify Cope's statement that there are *two* upper incisors.

Cope's associated type of *S. bucco* (Am. Mus., Cope Coll., No. 6346) is the posterior half of a skull with very powerful, rounded, zygomatic arches. It is apparently a male skull, but does not certainly belong to this species.

The most closely related form is Marsh's species *T.* (*Brontops*) *robustum*. It may subsequently prove to be identical. Cope's associated type of *S. bucco* has the same zygomatic arch-section.

## 14. Titanotherium ophryas (*Cope*).

*Symborodon ophryas* COPE. (Type of genus *Miobasileus* COPE.)

*Type Loc.*—Colorado. Level not determined.

*Type.*—A fragmentary skull, including nasals and horns.

This is practically a *nomen nudum*. The original skull was broken up in removal and transportation, and the original description does not enable us to distinguish the species.

## 15. Titanotherium acer (*Cope*).

PLATE IV.

*Symborodon acer* COPE.
SYN. *S. altirostris* COPE. Type, a female skull of *T. acer*.
" *? Menodus syceras* COPE.

*Type Loc.*—Colorado. Level undetermined.

*Type.*—A male skull lacking the teeth and zygomatic arches. (Am. Mus., Cope Coll., No. 6348.)

*Spec. Char.—Horns* long, rising on stout maxillary column overhanging narial opening, sub-oval, antero-posterior section of base greater than transverse. ♂ Horns very long, recurved, flattened at summit, with a low connecting crest, and a slight external ridge. ♀ Horns shorter, directed forwards. *Nasals* very short, tapering to extremities. Occiput high and narrow, superior border not incurved. ♀ Zygomatic arch rather slender, slightly spreading. Premolar cingula reduced externally. ♀ Superior incisors vestigial. Lower jaws unknown.

This small species is sharply characterized by the antero-posterior oval form of the horns, the long narrow cranium, and the high slender occiput. The female skull (type of *S. altirostris* Cope, No. 6350, Am. Mus.) has shorter horns but precisely similar skull and nasal dimensions and characters. As in some other female skulls, the connecting crest between the horns is wholly wanting, and the superior incisors have dropped out, although apparently present in the young condition.

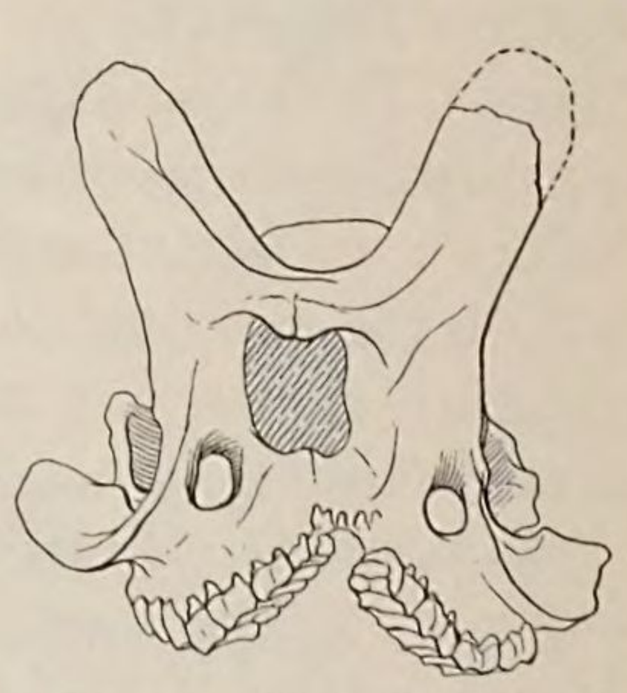


Fig. 3*A*. Skull of female *T.* (*altirostris*) *acer*. (No. 6350), front view.

A second female skull (No. 6349, Am. Mus., Cope Coll.) has horns somewhat flattened posteriorly, but is otherwise similar.

The type of *T. syceras* Cope[1] from the Swift Current Creek, Canada, exhibits horns and nasals of the same character as the above.

As in all the long-horned species examined by the writer, the external premolar cingula are nearly obsolete.

[1] Contr. Can. Pal., III, Pl. viii.

## 16. Titanotherium heloceras (*Cope*).

PLATE III.

*Symborodon heloceras* COPE.

*Type Loc.*—Colorado. Level unknown.

*Type.*—A skull with teeth, nasals and part of frontals wanting. (No. 6360, Am. Mus., Cope Coll.)

*Spec. Char.*—*Horns* rudimentary, divergent. Post-glenoid and post-tympanic processes not in contact. *Occiput* broad and low. Zygomatic arches slender, vertical, not spreading.

This animal is very imperfectly known. From the open condition of the external auditory meatus it is evidently a very primitive type. The rudimentary condition of the horns is possibly a female character. The type is of advanced age.

This animal probably had moderately broad, elongate nasals, and three upper and lower incisors. Unfortunately these parts are wanting in the type.

## 17. Titanotherium bucco (*Cope*).

PLATE III.

*Symborodon bucco* COPE.

*Type Loc.*—Colorado. Level unknown.

*Type.*—A complete skull and lower jaws. Sex unknown. (No. 6345, Am. Mus., Cope Coll.)

This species is a synonym of *T.* (*Symborodon*) *torvum* Cope, as determined by the almost identical characters and measurements of the lower jaws.

## 18. Titanotherium altirostris (*Cope*).

*Symborodon altirostris* COPE.

*Type Loc.*—Colorado. Level unknown.

*Type.*—A female skull. (No. 6350, Am. Mus., Cope Coll.)

The type of this species is a female skull of the species *T. acer* Cope, described above.

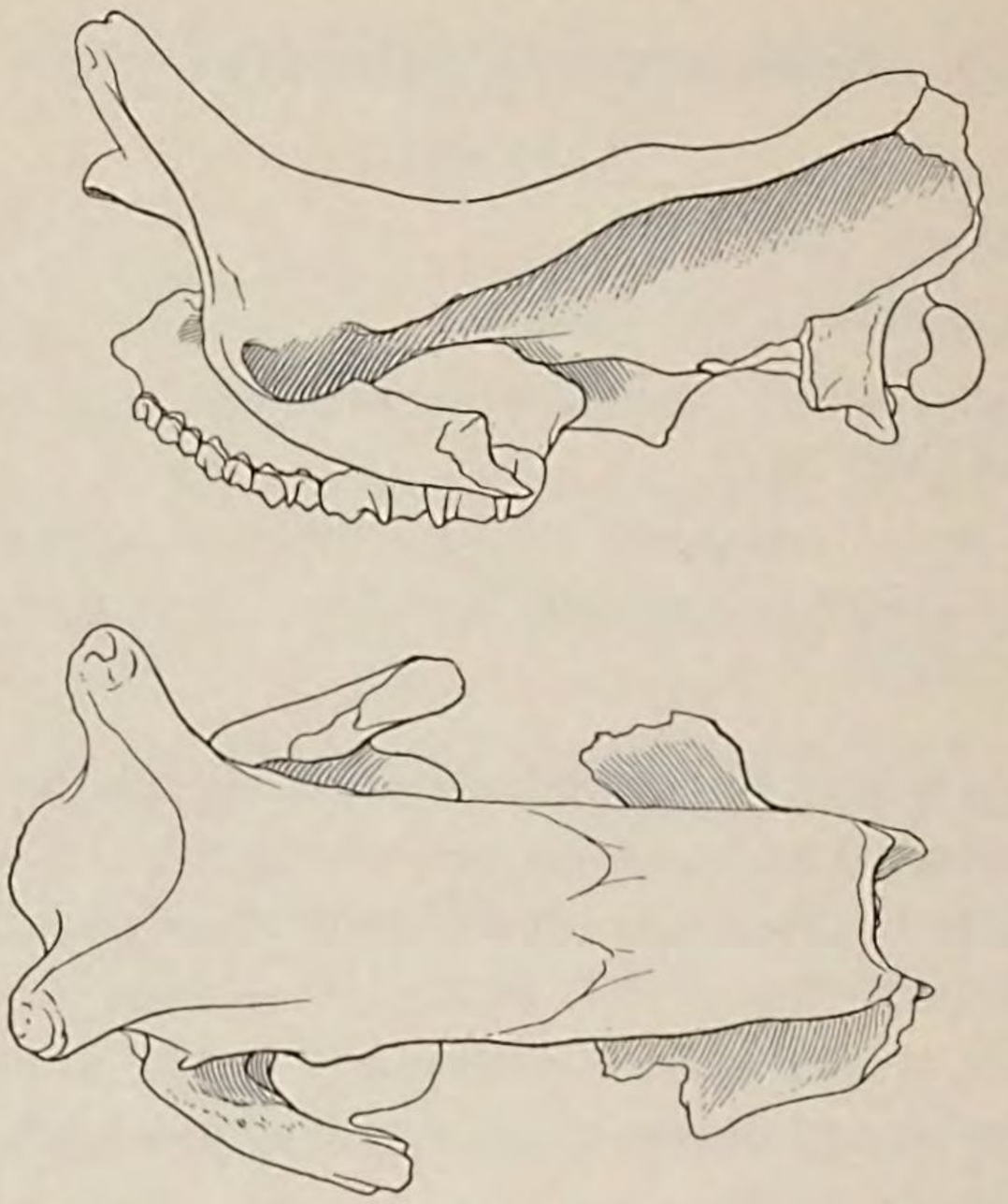


Fig. 4. Skull of female *T.* (*altirostris*) *acer*, side and top views (No. 6350). One-twelfth natural size.

## 19. Titanotherium trigonoceras (*Cope*).

PLATE III.

*Symborodon trigonoceras* COPE.

*Type Loc.*—Colorado. Level undetermined.

*Type.*—A cranium lacking the teeth. (No. 6355, Am. Mus., Cope Coll.)

*Spec. Char.*—*Horns* short, rising upon maxillaries, partly over the orbits; ♂ sub-triangular in section at base, directed outwards and upwards, in latest types united by low connecting crest; ♀ more slender and rounded superiorly, no connecting crest. *Nasals* very long, overhanging symphysis, square or broadening distally, notched. Zygomatic arch vertically deep in section, with an inferior lateral bulge in front of glenoid facet. Occiput low and broad, incurved upon superior border; ♂ robust lateral pillars. Incisors vestigial. Canines moderately large. Premolars with external and internal cingula. Dentition: $\frac{2-0}{}$, $\frac{1}{}$, $\frac{4}{}$, $\frac{3}{}$. Lower jaw unknown.

The type skull lacks most of the teeth. The associated type (Am. Mus., Cope Coll., No. 6356) exhibit four vestigial incisors. As observed by Cope,[1] it is of smaller size, substantially of the

[1] Bull. U. S. Geol. Surv. Terrs., 1873, p. 490. (Pub. 1874.)

same proportions and characters as *T.* (*Brontotherium*) *ingens* Marsh, but the latter is a distinct species. The last upper molar has quite a distinct second internal cone. The 'connecting crest' is feebly developed.

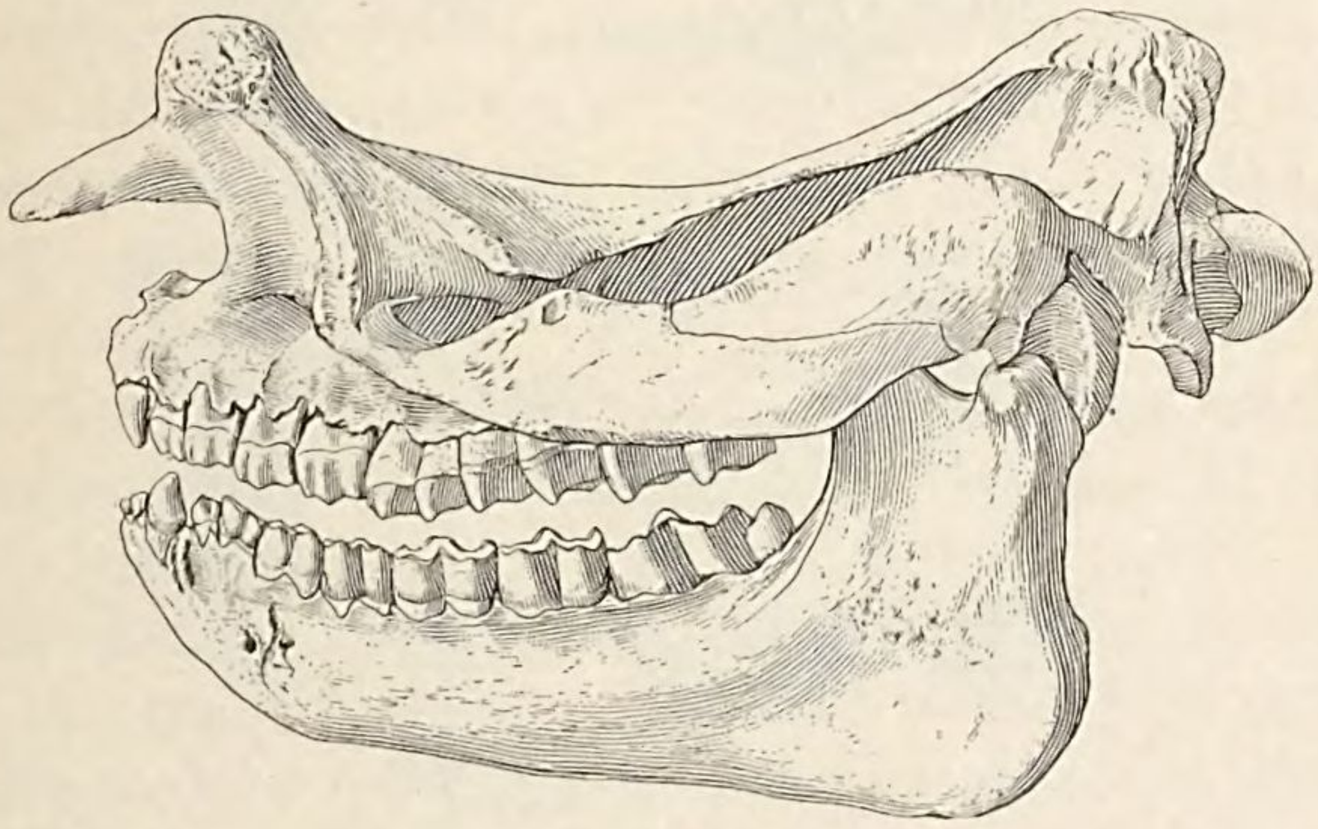


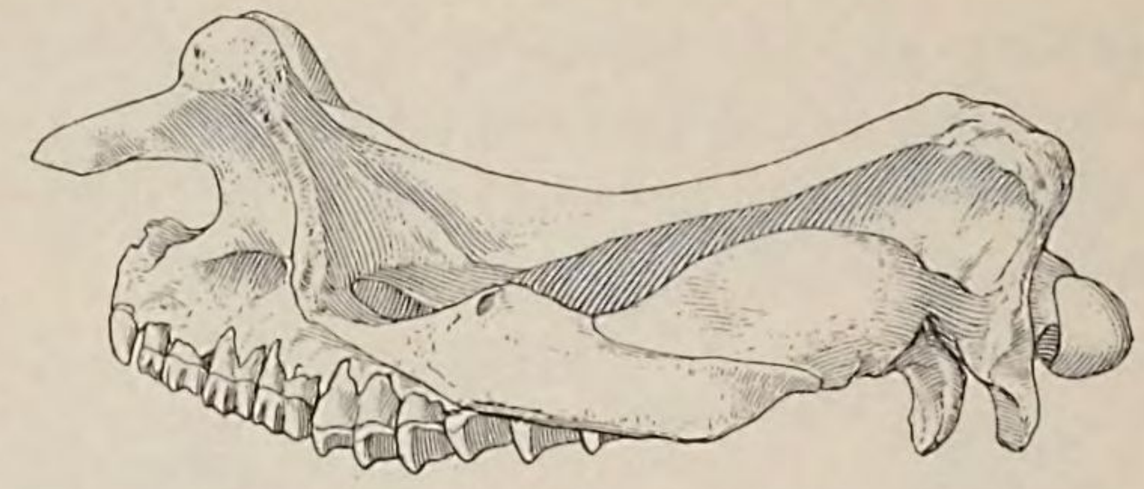
Fig. 5. *Titanotherium trigonoceras.* Skull (No. 1445) and lower jaws (No 516), found in the lower beds. One-tenth natural size.

Two fine skulls (Nos. 501, 1445) in the American Museum Collection are provisionally referred to this species, although the horns are less distinctly triangular, presenting a transition between *T. coloradense* and *T. trigonoceras.*

In No. 501 there are two upper incisors and no second internal cone upon the last upper molar. In the closely similar No. 1445 there are no evidences of upper incisors, and there is a decided second internal cone upon the last upper molar.

In other respects the two skulls agree quite closely. The 'connecting crest' is feebly developed, thus the horn section is a longitudinal oval with a triquetrous base. The nasals are long and expand somewhat distally. The occiputs are robust and somewhat indented superiorly. The post-glenoid and post-tympanic processes are in slight contact.

This species, characteristic of the lower beds and lower portion of the middle beds, is sharply defined. It is probably ancestral to *T. ingens* Marsh, which is confined to the middle beds and may be distinguished by the long pointed canines and very large size.



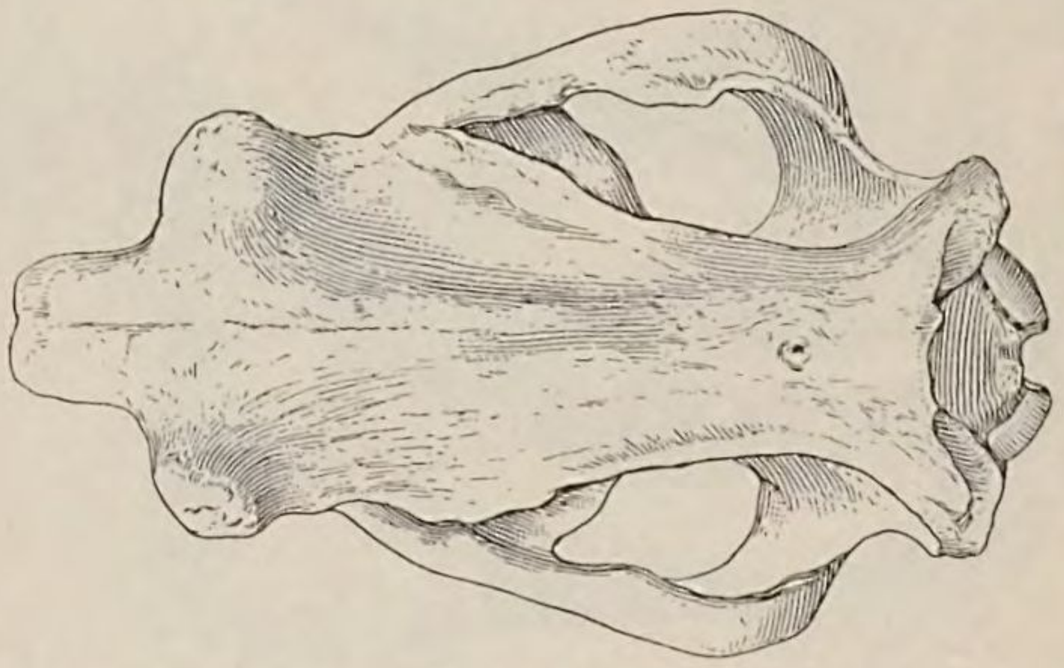


Fig. 6. *Titanotherium trigonoceras.* Skull (No. 1445), superior view. Skull (No. 501), in side view. One-twelfth natural size.

## 20. Titanotherium ingens (*Marsh*).

PLATE III.

*Brontotherium ingens* MARSH.

*Type Loc.*—

*Type.*—A complete male skull. Yale Univ. Mus.

*Spec. Char.—Horns* short, rising upon maxillaries partly above orbits; ♂ sub-triangular in section, with 'connecting crest'; directed strongly upwards and outwards. ♀ more slender, elongate oval in form, no 'connecting crest.' Nasals in both sexes, long, expanding and rugose distally, notched. Zygomatic arch with a deep vertical section, and a decided bulge just in front of glenoid facet, strongest in ♂ skulls. Incisors ? 2–0, vestigial or wanting. Canines very long and pointed, extending below level of premolars, ♂ robust, ♀ slender. Premolars and molars with robust external and internal cingula. Second internal cone of last upper molar variable, sometimes strongly distinct. Dentition: $\frac{2-0}{2-0}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$.

The four fine skulls (Nos. 505, 506, 1066, 1067) in the American Museum Collection are referred to this species, although in all of them *the upper incisors are vestigial or wanting*. Marsh assigns two upper incisors to his type, but the premaxillaries are apparently wanting.

Two of these skulls (Nos. 506, 1067) are apparently females, the horns are more slender and pointed; the upper and lower canines are long but less robust. Neither skull has any trace of upper or lower incisors.

Of the supposed male skulls No. 505 agrees exactly with Marsh's type specimen; the outer upper incisor is represented by one small alveolus, the tooth has disappeared. The other skull, No. 1066, has *two* vestigial alveoli. It is apparent that in this species, so closely related to *T. trigonoceras*, the *upper incisors are variable, vestigial or wanting*.

These two male skulls have strong canines, more robust zygomatic arches, and strong 'connecting crests' between the very stout triangular horns.

We can readily distinguish this species by the vigorous development of the canine, premolar and molar teeth, which far surpass in size and in the development of cingula those of any other type. (See measurements, Table II.)

Vertical or lateral crushing greatly alters the angles and appearance of the horns. Skull No. 1066 is vertically crushed, and thus closely resembles the type of *Menops varians* Marsh.

## 21. Titanotherium hypoceras (*Cope*).

*Symborodon hypoceras* Cope.

*Type Loc.*—Colorado. Level unknown.

*Type.*—A fragmentary cranium, parts of nasals, maxillaries, frontals, etc. (Am. Mus. Nat. Hist., Cope Coll., No. 6361.)

This species is indeterminate, owing to the fractured condition of the type. The horns resemble those of a young individual, or of a female skull.

## 22. Titanotherium montanum (*Marsh*).

*Anisacodon montanus* Marsh, Am. Jour. Sci. 1875, p. 245.
? Syn. *T. elatum* Marsh.
*Diconodon* (non-*Anisacodon*) Marsh, Am. Jour. Sci. 1876, p. 339.

*Type Loc.*—Not published.

*Type.*—A fragmentary skull, including the maxillaries. The chief character assigned to distinguish this genus and species is the large second internal cone

upon the last upper molar ; this character is of very doubtful taxonomic importance, since this cone is a variable character, as we have seen above in *T. trigonoceras* and *T. ingens.* The dentition assigned by Marsh is : $\frac{0}{1}, \frac{1}{1}, \frac{4}{3}, \frac{3}{3}$.

The skull referred to this species by Marsh, in the National Museum Collection, resembles a female skull of *T. elatum ;* the horns of transverse oval section are short, placed above the nares, directed forwards and united at the base by a strong connecting crest.

## 24. Titanotherium angustigenis (*Cope*).

*Menodus angustigenis* COPE, Ann. Rep. Geol. Surv. Canada, 1886, C. p. 81.
*Haplacodon angustigenis* COPE, Am. Nat. March, 1889, p. 153.

*Type Loc.*—White River Beds of Swift Current Creek, Canada.

*Type.*—Two maxillary bones. Assoc. type : Two lower jaws.

The characters of the type do not enable us to define this species satisfactorily. The *associated* type is readily distinguished by the extreme narrowing of the *symphysis mandibuli.* The type is interesting as exhibiting three premolars upon one side and two upon the other, and demonstrating the variability of these teeth. The genus *Haplacodon* has not been retained by its author.

## 25. Titanotherium tichoceras (*Scott & Osborn*).

PLATE III.

*Menodus tichoceras* S. & O. Bull. Mus. Comp. Zoöl. Aug. 1887, p. 157.

*Type Loc.*—South Dakota. Level unknown.

*Type.*—A skull and teeth ; horns partly broken. Coll. Harv. Univ. Mus.

*Spec. Char.—Horns* sub-triangular to cylindrical in section, rising between orbits and nares, inclined forwards and outwards ; not united by connecting crest. *Nasals* of medium length, slightly tapering. Zygomatic arch deep, with a bulge opposite glenoid facet. Occiput unknown. Two superior incisors. Premolars without external cingulum ; internal cingulum reduced or obsolete. Dentition : $\frac{2}{}, \frac{1}{}, \frac{4}{}, \frac{3}{}$.

This species is clearly distinguished from the *T. trigonoceras* and *T. ingens* type by the decidedly more anterior position and

more rounded section of the horns, by the correspondingly shorter nasals, and by the absence of external cingulum upon the premolars. It resembles these species closely in the form of the zygomatic arch. The sex of the type is uncertain; the rather large canines indicate that it is a male skull. It might be considered a female skull of *T. dolichoceras* but for the longer nasals and wholly different horn-section.

## 26. Titanotherium dolichoceras (*Scott & Osborn*).

PLATE IV.

*Menodus dolichoceras* S. & O. Bull. Mus. Comp. Zoöl. Vol. XIII, Aug. 1887, p. 158.

*Type Loc.*—South Dakota. Level unknown.

*Type.*—A male skull, lacking dentition and zygomatic arches. Coll. Harv. Univ. Mus.

*Spec. Char.*— ♂ *Horns* long, placed above nares, forwards and outwards, with an oval section placed obliquely to the longitudinal axis of the skull; no connecting crest. *Nasals* very short, tapering. Occiput not very broad. Premolars with reduced external cingulum.

The horns in this species are placed as in *T. robustum*, but the oval section is oblique instead of transverse, and the nasals are much shorter. This position and section of the horns is highly characteristic. A close approach to it is found in the type of *T.* (*Allops*) *serotinus* Marsh, which may prove to be a female skull of *T. dolichoceras*. The sections are shown in Diagram II.

## 27. Titanotherium platyceras (*Scott & Osborn*).

PLATE IV.

*Menodus platyceras* S. & O. Bull. Mus. Comp. Zoöl. Vol. XIII, Aug. 1887, p. 158.

*Type Loc.*—South Dakota. Upper Titanotherium Beds.

*Type.*— ♂ A pair of horns. Nasals imperfect. Coll. Harv. Univ. Mus. Assoc. type, Coll. Am. Mus., No. 1448.

*Spec. Char.*— ♂ *Horns* placed vertically in front of symphysis, extremely flattened transversely, directed forwards, upwards, and slightly recurved; united by a deep connecting crest; rugose at extremities, with an external ridge extend-

ing towards malars. *Nasals* extremely short, deeply notched. Zygomatic arches expanding into two broad flattened rugose plates. Occiput low, deeply indented, with stout lateral pillars. External auditory meatus enclosed by deep union of post-glenoid and post-tympanic. Canines stout, obtuse. Two pairs of upper incisors. Premolars with obsolete external cingulum. $\frac{3}{3}$ Dentition : $\frac{2}{2}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$.

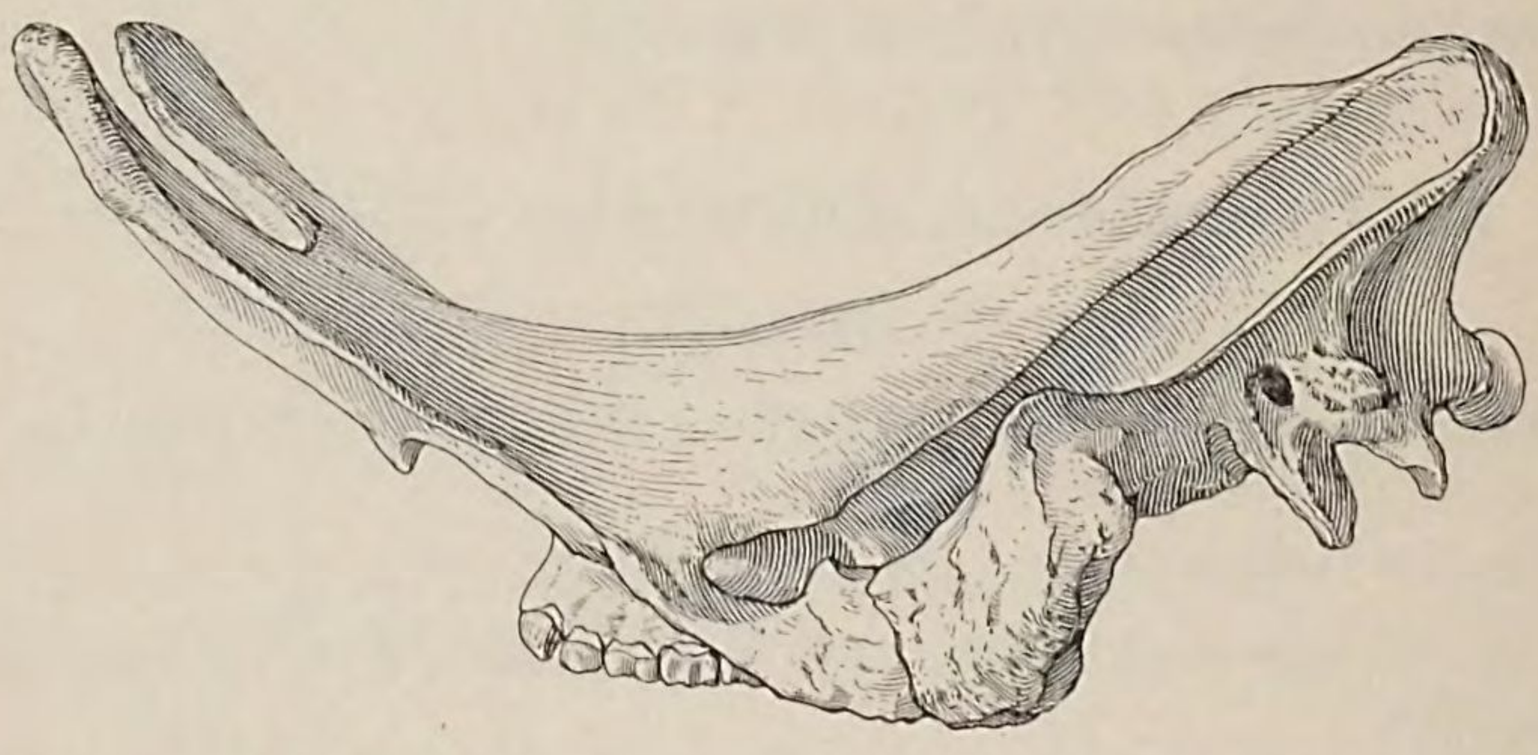


Fig. 7. *Titanotherium platyceras.* Skull (No. 1448), in lateral view. The occipital region is composed of fragments placed together in plaster. One-tenth natural size.

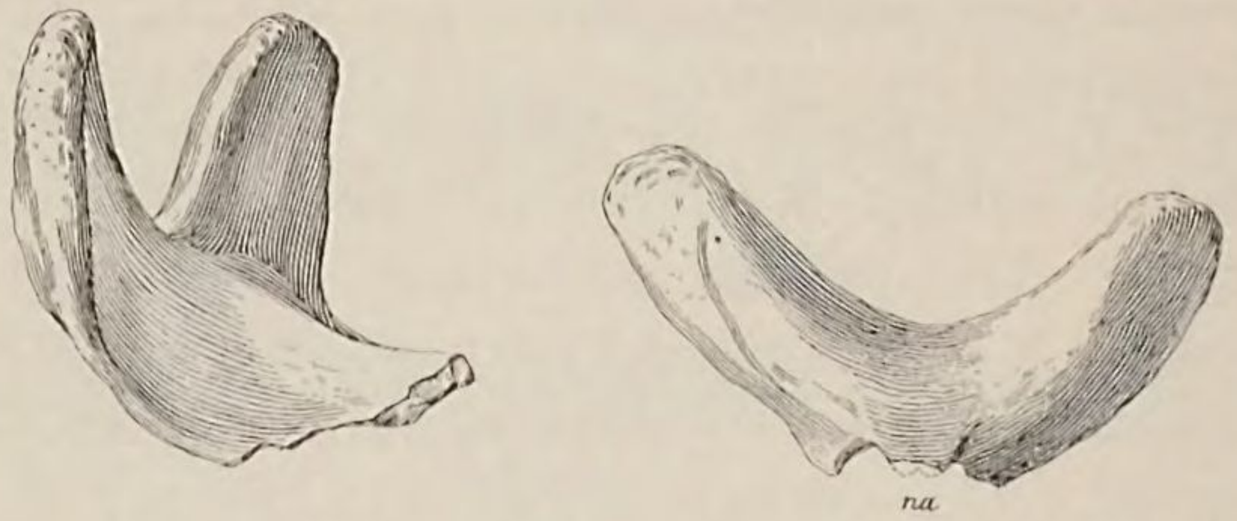



Fig. 7*A*. *Titanotherium platyceras.* Type. Horns and fragmentary nasals. Harv. Univ. Mus.

The characters originally assigned to this species from the type horns in the Harvard University Museum are now reinforced by a superb male skull in the American Museum Collection (No. 1448). It apparently represents the very latest stage of development of the Titanotheres before their sudden extinction. The extreme anterior position of the horns, their flattened section, the deep connecting crest, the vestigial nasals, the great zygomatic plates, the deeply excavated occiput—all are in a terminal phase beyond which further specialization seems impossible. At the

same time it is noteworthy that in this skull both the incisors are retained and the last molar shows only a slight distinctness of the second cone, indicating that this character is not essentially a progressive one. The premolar cingula are markedly reduced. The horn sections are shown in Diagram I. The figures of the skull are inaccurate in not clearly indicating that the posterior part of the cranium is largely fragmentary and restored.

## 28. Titanotherium robustum (*Marsh*).

*Brontops robustus* MARSH.

*Type Loc.*—Upper Titanotherium Beds.

*Type.*—A perfect skull and nearly complete skeleton. Coll. Yale Univ. Mus.

*Spec. Char.*—*Horns* placed anteriorly, above nares, directed forwards and outwards, transverse oval in section, no connecting crest. *Nasals* somewhat below medium length, slightly tapering or nearly square distally. Zygomatic arch with a strong outward projection, rounded in outer section. Premolars with reduced external cingula. Dentition : $\frac{2}{1}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{3}{3}$.

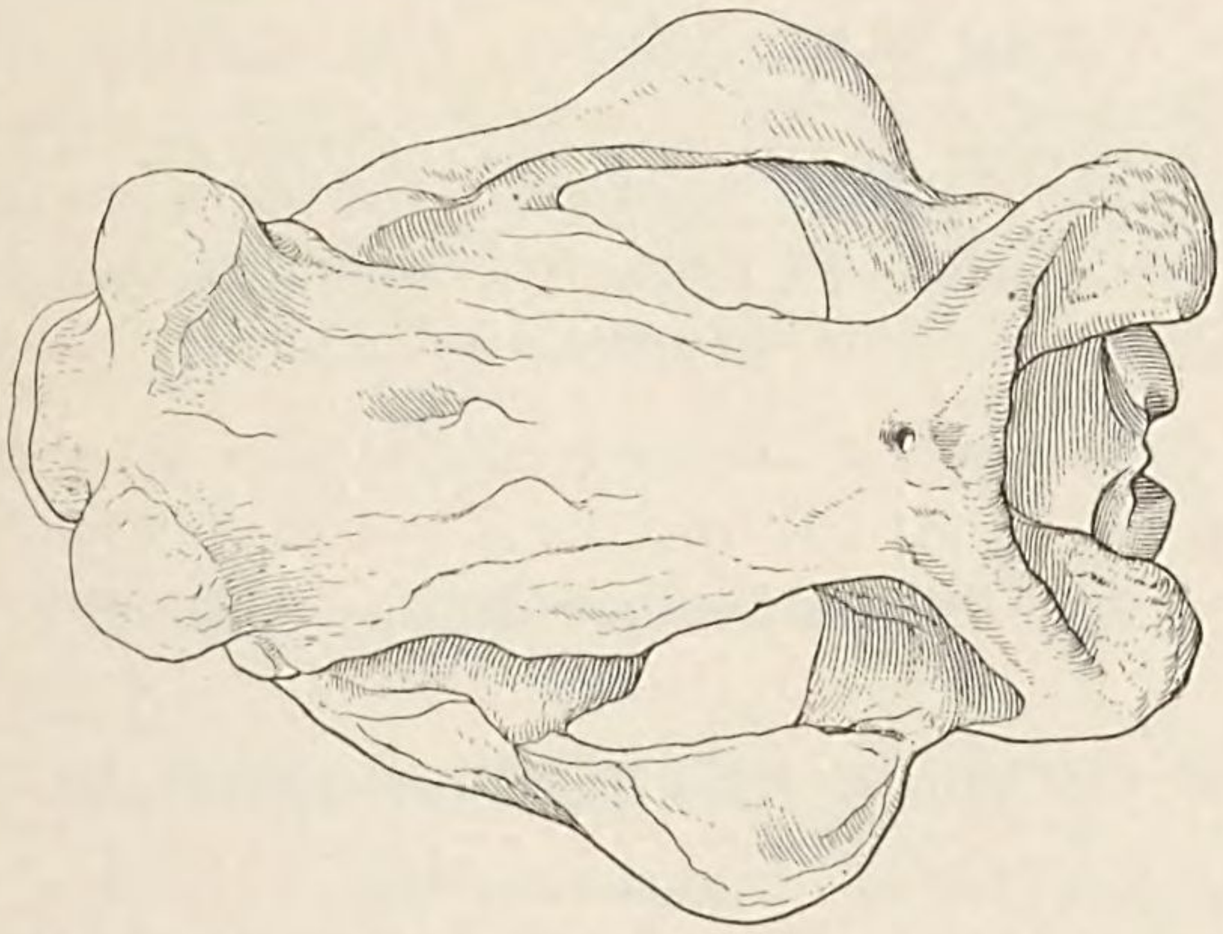


Fig. 8. *Titanotherium robustum.* Skull (No. 1069), in superior view. One-twelfth natural size.

Marsh's type is a superb skull and jaws and nearly complete skeleton, which was figured and fully described in 1889.[1] This

[1] Am. Jour. Sci., Feb., 1889, p. 163, Pl. vi.

animal approaches *T. torvum* Cope, but appears to differ specifically in the stronger transverse oval of the horns (compare sections in Diagram II), and in the less extensive outward arching of the zygomata. In *T. torvum* the expansion of the arch is somewhat flattened vertically; in *T. robustum* the swelling is vertically rounded (as in Cope's associated type). These differences, however, may subsequently be found not to possess specific value.

Two fine skulls in the American Museum Collection (Nos. 1069, 1083) apparently belong to this species, although the nasals are somewhat longer and more quadrate distally. They exhibit the same transverse oval horn section, two strong upper incisors, the alveoli of powerful canines, the absence of a connecting crest between the horns.

Judging by the large upper canines, Marsh's type is the skeleton of a male, the sexual characters of this species have yet to be determined. Some light is thrown upon this by No. 508.

The skull and nearly complete skeleton (508) in the American Museum have already been described as a *female* of this species in a previous number of the Bulletin. Unfortunately the canines and alveolar borders of the incisors are wanting, depriving us of these characters so distinctive of sex. The horns are feebler, and the zygomatic arches are much less expanded than in Marsh's type, indicating that this is a female animal.

## 29. Titanotherium dispar (*Marsh*).

*Brontops dispar* Marsh, Am. Jour. Sci. 1887, pp. 327, 329.

*Type Loc.*—South Dakota Titanotherium Beds.

*Type.*—A nearly complete skull with lower jaws and entire dentition. Coll. U. S. Geol. Surv.

This species has not as yet been defined in such a manner that its position can be determined.

## 30. Titanotherium varians (*Marsh*).

PLATE III.

*Menops varians* MARSH, Am. Jour. Sci. 1887, p. 328.

*Type Loc.*—South Dakota. Titanotherium Beds.

*Type.*—"Skull of a large adult male."

Marsh has distinguished this species by the formula $\frac{2}{}, \frac{1}{}, \frac{4}{}, \frac{3}{}$. The horns are directed outwards and subtriangular in section, and the connecting crest is very low. The nasals are elongate, spreading, and notched distally.

We cannot, from the characters given, clearly distinguish this species from *T. trigonoceras* or *T. ingens*, to which it is apparently related.

## 31. Titanotherium curtum (*Marsh*).

PLATE IV.

*Titanops curtus* MARSH. (Type of Genus *Titanops*.)

*Type Loc.*—Colorado. Probably Upper Titanotherium Beds.

*Type.*—A complete male skull, with imperfect premaxillaries.

*Spec. Char.*—♂ *Horns* placed above narial opening, transverse flattened oval section, directed upwards, outwards and forwards, with an external crest to malars and a strong connecting crest. *Nasals* extremely reduced. Zygomatic arches moderately expanded. Canines powerful.

This species is intermediate between *T. elatum* and *T. ramosum*. The horn section is similar to that in *T. elatum*, but the nasals are very much more abbreviated.

## 32. Titanotherium elatum (*Marsh*).

PLATE IV.

*Titanops elatus* MARSH.

?SYN. *Diploclonus amplus* MARSH.

*Type Loc.*—South Dakota. Upper Titanotherium Beds.

*Type.*—A male skull lacking zygomatic arches.

*Spec. Char.*—*Horns* placed above anterior nares and symphysis; directed forwards, upwards and outwards; transverse oval (flattened posteriorly) in sec-

tion ; united by connecting crest. ♂ Horns elongate, vertical and recurved, rounded at tip ; a strong external ridge to malars ; deep connecting crest. ♀ Horns short, projecting forwards, pointed, rugose, or imperfectly ossified at tips, connecting crest less prominent or wanting. *Nasals* ♂ ♀ rather narrow and short, tapering, somewhat variable in length and size, notched distally. Zygomatic arch spreading ♂ with broad, vertically-compressed plates ; ♀ with a stout rounded projection. Occiput low and broad, ♂ with powerful lateral crests, ♀ with moderate lateral crests. Incisors, ♂ 2-1, ♀ variable 2-0. Canines short, obtuse, ♂ powerful, ♀ small, feeble.

Marsh's type is an imperfect male skull which he has briefly characterized.

The above definition is from an exceptionally fine male skull (No. 492, Am. Mus. Coll.), and from a less complete male skull and perfect pair of jaws (No. 1070, Am. Mus. Coll.). These are apparently identical with Marsh's type. The *female* characters

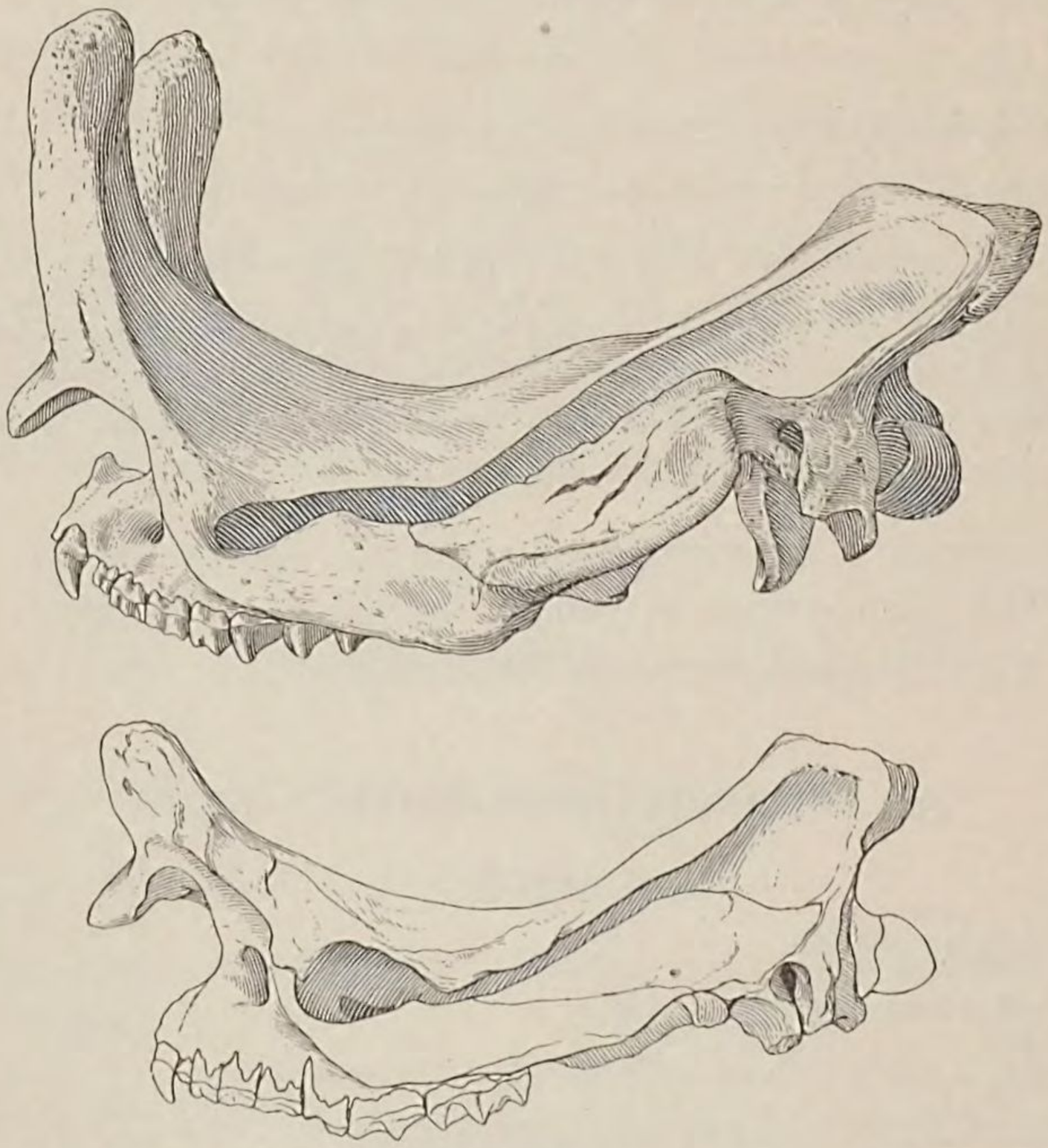


Fig. 9. *Titanotherium elatum*. Male (No. 492) and female (No. 1006) skulls, contrasted in lateral view. One-twelfth natural size.

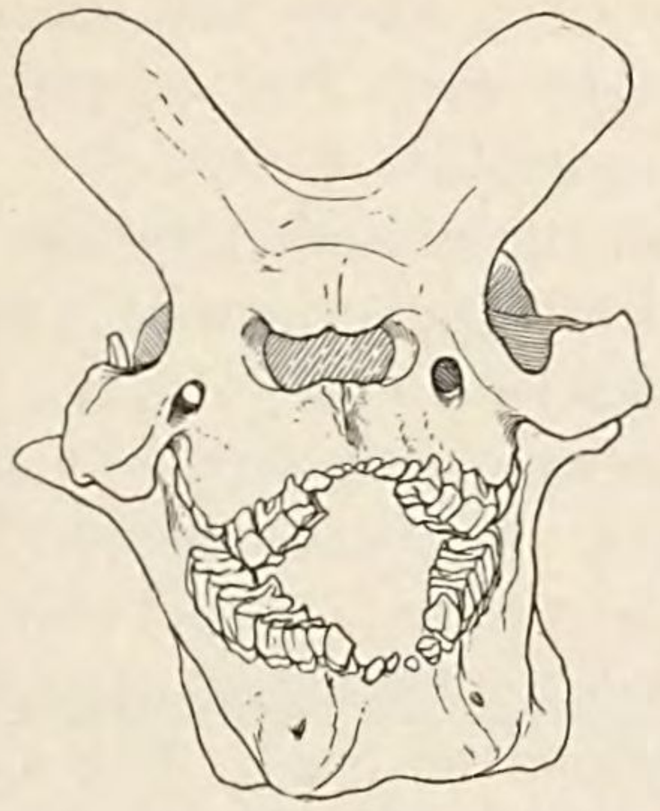


Fig. 10. *Titanotherium elatum.* Skull and jaws (No. 1070), in front view. One-twelfth natural size.

are taken from four smaller skulls found in the same geological level, distinguished by a rusty-brown color. In these skulls the horns are much shorter but have the same section, position and strong connecting crest, and it is highly probable that they are females of *T. elatum.* If this conclusion is correct we derive from these skulls a number of very important facts.

Both *male* skulls (492, 1070) exhibit a strong pair of upper incisors. The lower jaw of 1070 exhibits two lower incisors. No. 492 is characterized by short robust canines, very long recurved horns, massive zygomatic arches, extending into flattened plates, a robust deeply incurved occiput, small but well-formed nasals.

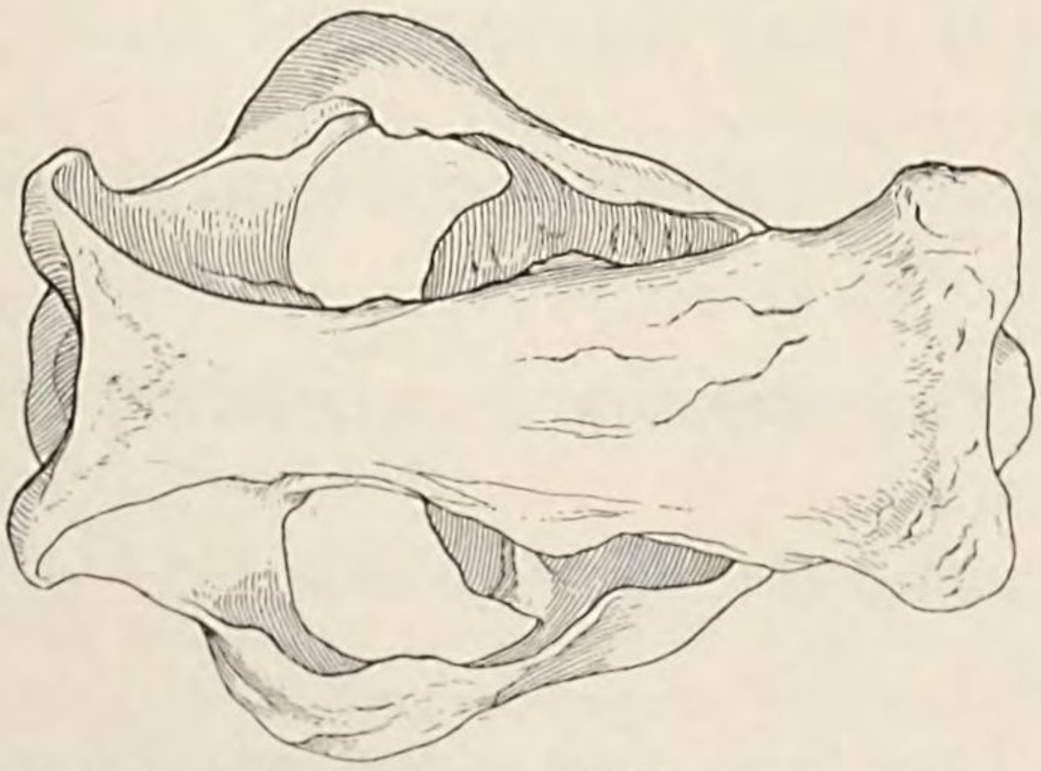


Fig. 11. *Titanotherium elatum.* Female skull (No. 1005), superior view. One-twelfth natural size.

In the supposed *female* skulls we find less perfect nasals, short horns, strong connecting crests, less expanded zygomata, feeble canines and extremely variable incisors.

In No. 1005, a small female skull, there are no upper incisors.

In No. 1006, a somewhat larger female skull, there is one small upper incisor upon each side.

In No. 1008, otherwise closely similar to the above skulls and found in the same level, there is also one small upper incisor upon each side, the horns are pointed (instead of rounded or obtuse as in Nos. 1005, 1006), and exhibit rugose projections upon the inner side about one-third from the base. This specimen agrees very closely with the type of *T.* (*Diploclonus*) *amplum* Marsh.

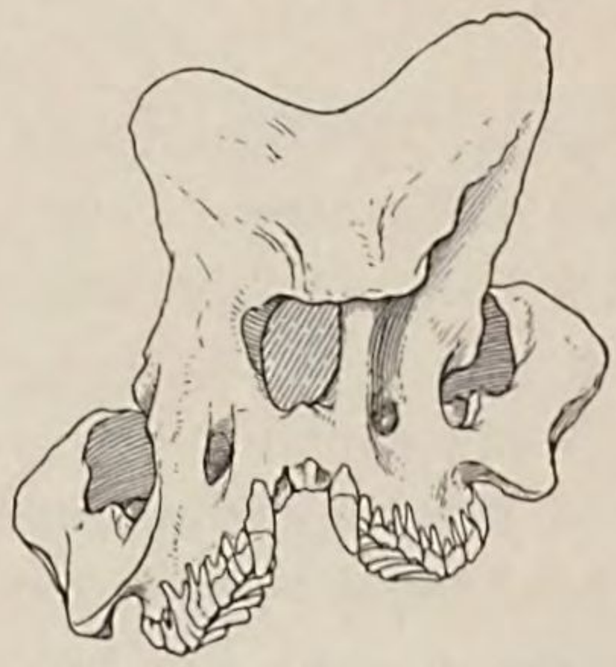


Fig. 12. Skull of female *T. elatum* (No. 1006). One-twelfth natural size.

### Lower Jaws.

The very large pair of lower jaws (No. 1051) may be provisionally referred to this species, although the dental series is longer than in the male skull No. 492. They exhibit short, robust canines, two stout incisors, premolars without external cingula. The large mental foramen opens directly below the third premolar.

## 33. Titanotherium serotinum (*Marsh*).

*Allops serotinus* Marsh.

*Type Loc.*—South Dakota. Level not published.

*Type.*—A skull.

Marsh distinguishes this species by the dental formula $\frac{1}{1}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$. It has not yet been figured or defined. An examination of the

type specimen indicates that skull No. 520, in the American Museum, is very similar. This in turn is most closely related to *T. dolichoceras.* This skull has small outer incisors only. The horns have no 'connecting crest'; they diverge widely and have an oval section, obliquely placed. The nasals are short and deeply notched; the zygomatic arches are moderately expanded. The summit of the occiput is more deeply incurved than in the type of *T. dolichoceras.*

## 35. Titanotherium selwynianus (*Cope*).

*Menodus selwynianus* COPE, Am. Nat. 1889, p. 628.

*Type Loc.*—Swift Current Creek, Canada.

*Type.*—Nasals detached from skull.

*Spec. Char.—Nasals* prominent, narrow and vaulted, lateral borders nearly parallel, extremities rounded.

This species is very imperfectly known. As described by Cope,[1] it appears to be a primitive and distinct species.

## 36. Titanotherium syceras (*Cope*).

*Menodus syceras* COPE, Am. Nat. 1889, p. 628.

*Type Loc.*—Swift Current Creek, Canada.

*Type.*—Coössified nasals with horns.

The type of this species resembles very closely the female nasals and horns of *Titanotherium acer* Cope.

## 37. Titanotherium amplum (*Marsh*).

*Diploclonus amplus* MARSH, Am. Jour. Sci. 1890, p. 523.

*Type Loc.*—Not published.

*Type.*—"A nearly complete skull."

*Spec. Char.—Horns* high, compressed transversely with a strong connecting crest; a prominent knob upon inner superior margin; an external ridge. *Nasals* projecting very little. Zygomatic arches widely expanded. Last upper molar with two cones. ? Two upper incisors.

[1] The nasals are figured in Pl. V, Figs. 3, 3*a*, 3*b*, Contr. Can. Pal., Vol. III, p. 17.

The above definition is from the author's description. The internal knob appears to be an *individual variation* rather than a specific or generic character. As above noted it appears in our collection in a skull which is probably a female of *T. elatum*, yet closely similar to Marsh's type of *T. amplum*. This knob is also seen in the horns of skull No. 1081 of our collection, which we provisionally refer to *T. torvum*.

## 38. Titanotherium avum (*Marsh*).

*Teleodus avus* MARSH, Am. Jour. Sci. 1890, p. 524.

*Type Loc.*—Not published.

*Type.*—Not stated. Characters assigned in lower jaw.

This species is characterized by the presence of three lower incisors in each jaw. The type has but three lower premolars. Hatcher believes that this species possesses a trapezium.

This character and the presence of three lower incisors unites this genus with *Diplacodon*.

## 39. Titanotherium ramosum, sp. nov.

PLATE IV.

*Type. Loc.*—Upper Titanotherium Beds. South Dakota.

*Type.*—A complete male skull, lacking incisor border. (No. 1447, Am. Mus. Nat. Hist.)

*Spec. Char.*—♂ *Horns* placed above symphysis, greatly expanded at the summits, section plano-convex ; a strong 'connecting crest,' *Nasals* extremely short. Zygomatic arches expanded into two wide flat plates. Incisors and canines unknown. Premolars with reduced external cingula.

The distal spreading or branching of the horns is the character by which this species is designated. It differs from *T. elatum* in this character, but more especially in the great depth of the 'connecting crest' and the extreme flattening of the horns, the section as shown in Diagram I, being intermediate between that of *T. elatum* and of *T. platyceras*. It is remarkable that the teeth in this large skull are relatively of small size; the last upper molar has no second cone.

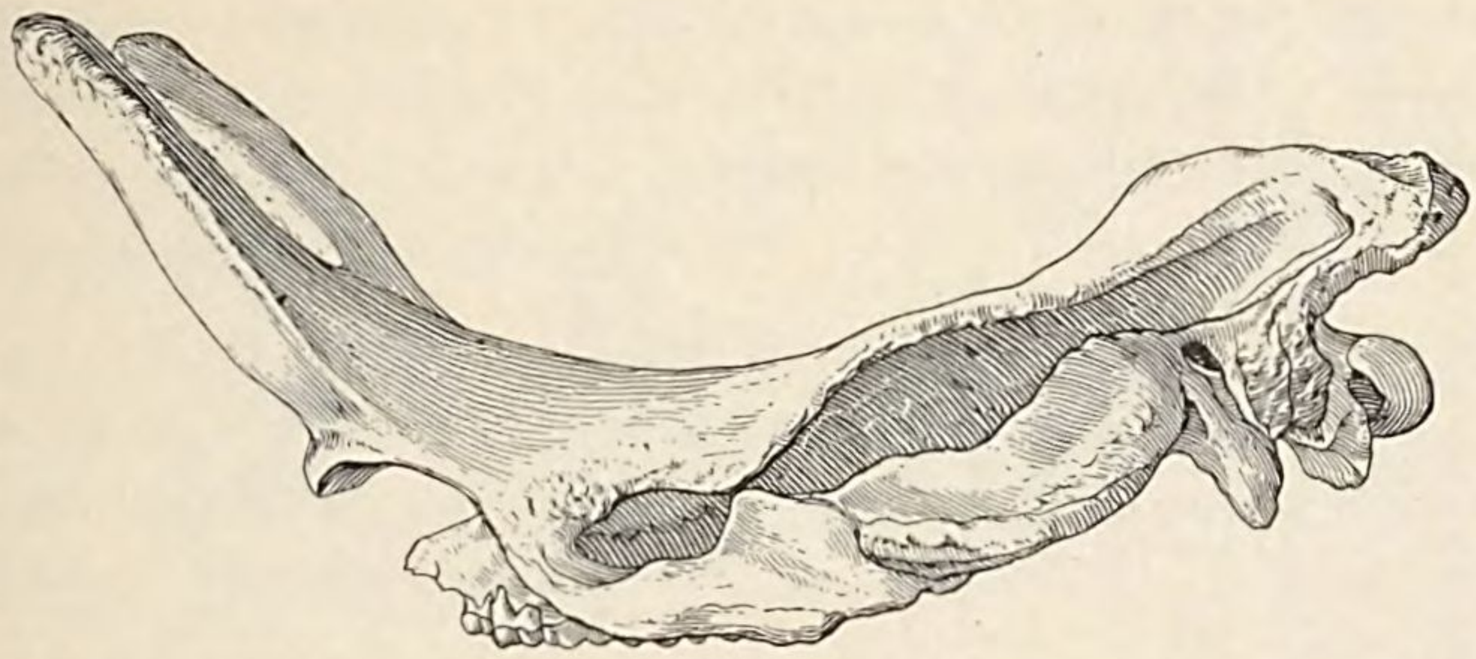


Fig. 13. *Titanotherium ramosum.* Type skull (No. 1447), in lateral view. One-twelfth natural size.

Found near this skull was a pair of lower jaws (No. 1449) containing teeth of lesser longitudinal measurement. The chin is very shallow. There are two robust incisors upon each side; the canines are short and obtuse; the premolars lack the external cingula. The formula is $\frac{2}{2}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$.

## Characters of Lower Jaws.

It is not possible to satisfactorily determine the specific characters of the lower jaws from the materials at our disposal.

No. 516.—This is a fine pair of small jaws from the lower beds with a formula $\frac{2}{2}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$. The dental series is of exactly the same size as in skulls Nos. 501 and 1445, indicating that these jaws belong to *T. trigonoceras*, but the incisors are much more strongly developed than in any of the known skulls of this species.

Nos. 1067, 506.—These jaws are both associated with female skulls of *T. ingens*. The rami are long and deep, with a full well-rounded chin. No lower incisors; strong cingula.

Nos. 6345, 6365.—These jaws, belonging to *T. torvum*, are much shorter and shallower than in *T. ingens*. No lower incisors; feeble external cingula.

Nos. 1052, 508.—These jaws, belonging probably to *T. robustum*, are distinguished by the very large size of the mental foramen, which is placed beneath the line between the third and fourth premolars. Canines stout in male (1052). Cingula feeble.

TABLE III.—DIVISION OF THE TITANOTHERIUM BEDS, AND VERTICAL DISTRIBUTION OF SPECIES.

| | WHITE RIVER BEDS, COMPOSITE SECTION, OLIGOCENE. | CHARACTERISTIC SPECIES. |
|---|---|---|
| TOTAL THICKNESS, 180 FEET. Upper Beds, 80. | Titanotheres of large and medium size. Males with horns 8 to 17 inches in length, placed above nares, transverse oval or flattened in section, usually a connecting crest. Nasals pointed, medium or short. Premolars with reduced cingula. Incisors 2–0. External auditory meatus deeply enclosed. | *T. platyceras*, 1448.<br>*T. ramosum*, 1447.<br>*T. elatum*, 492.<br>*T. robustum*, 518. |
| Middle Beds, 100. | Titanotheres of large and medium size. Males with horns 7 to 9 inches in length, placed above maxillaries, oval or triangular in section; sometimes a connecting crest. Nasals long, quadrate. Incisors 2–0. Premolar cingula varying. External auditory meatus always closed below. | * *T. tichoceras.*<br>*T. ingens*, 505.<br>* *T. trigonoceras.* |
| Lower Beds, 50. | Titanotheres of medium and small size. Horns from 4 to 6 inches in length, placed above maxillaries, antero-posterior oval to sub-triangular section, no connecting crest. Nasals long. Incisors 3–0. Premolar cingula varying. External auditory meatus sometimes closed below. | *T. trigonoceras*, 501.<br>*T. coloradense.*<br>* *T. heloceras*, 6360. |

No. 1051.—This jaw of unusual size is provisionally referred to *T. elatum*. The lower border reaches an angle below the fourth premolar, and in front of this extends upwards into a shallow chin. Cingula upon premolars feeble.

Nos. 1061 and 1068 represent the latest type of jaw, belonging either to *T. elatum* or *T. ramosum*. As in the above (No. 1051) the chin tapers rapidly upwards from a point below the fourth premolar. Cingula feeble.

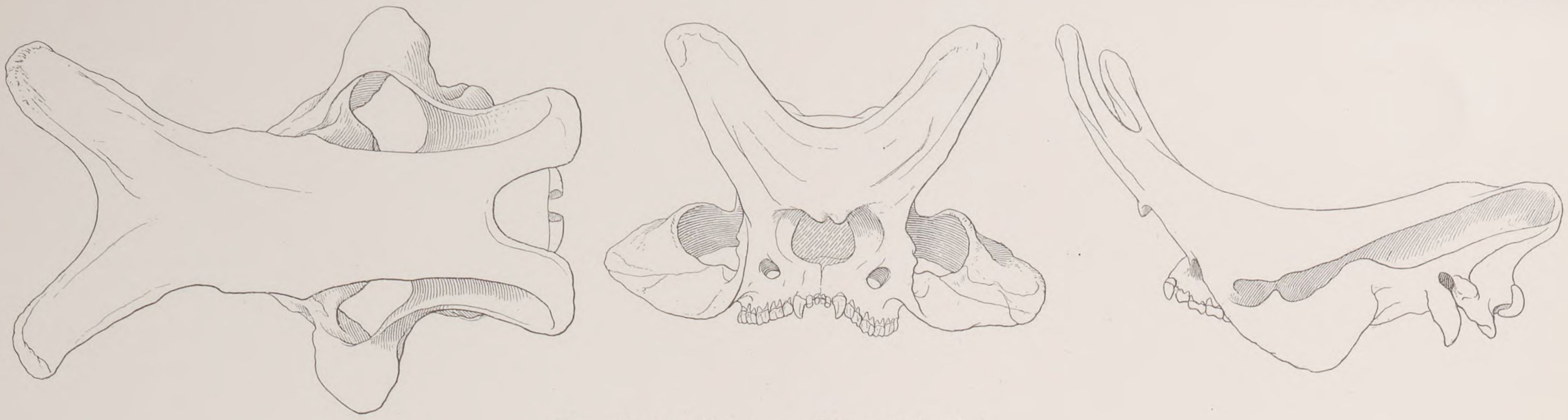
## III.—Distribution.

The relation of the evolution of the Titanotheres to the geological levels was first clearly pointed out in an important article by Hatcher.[1] The above table is his, with some modifications and the addition of the specific forms characteristic of the various beds so far as they are known. The geological level of the species marked with a * is still a matter of inference, not of record.

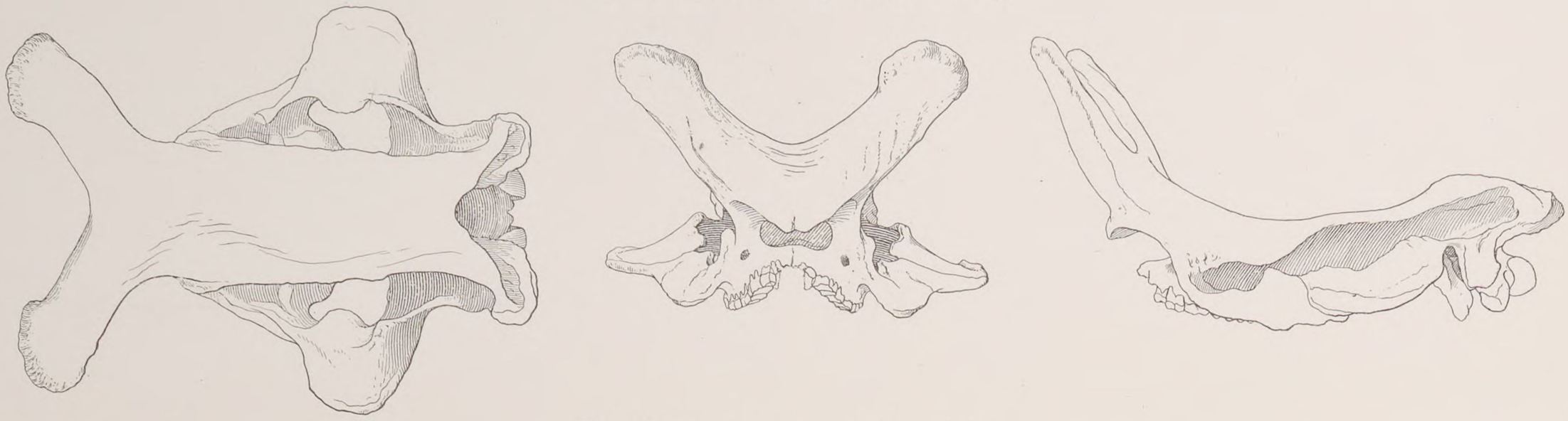
It is true that the above inductions as to growth, sexual and variable characters require confirmation by the examination of a very large number of skulls. In general they are probably correct. They indicate that the principles of generic and specific division adopted by Cope, and in a large degree by Marsh, are wholly untenable—for the strict application of these principles would multiply genera and species *ad infinitum*.

The phylogeny of the species is still so obscure that it is rash to speculate about it.

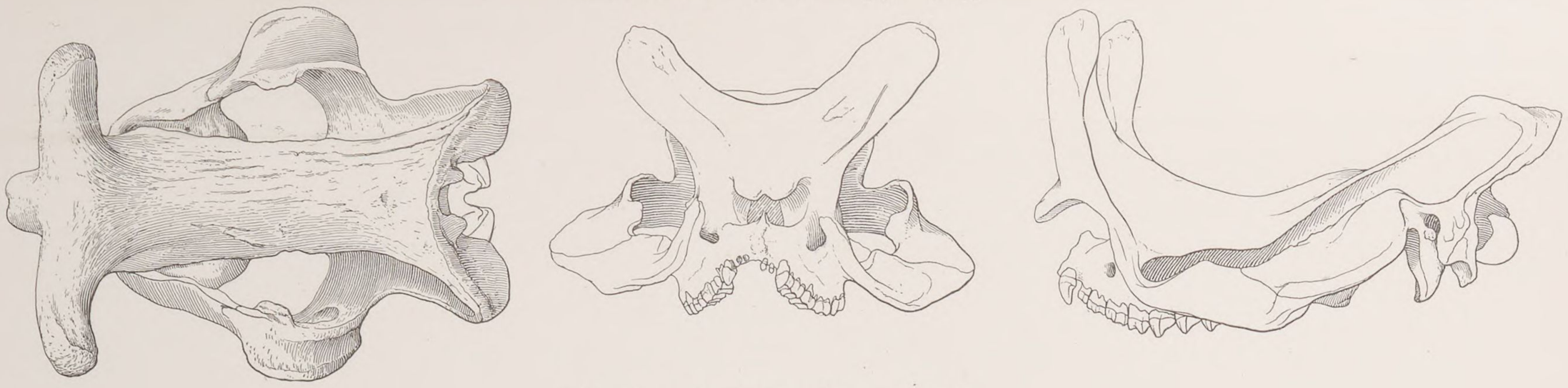
[1] 'The Titanotherium Beds,' American Naturalist, March, 1893, p. 204.



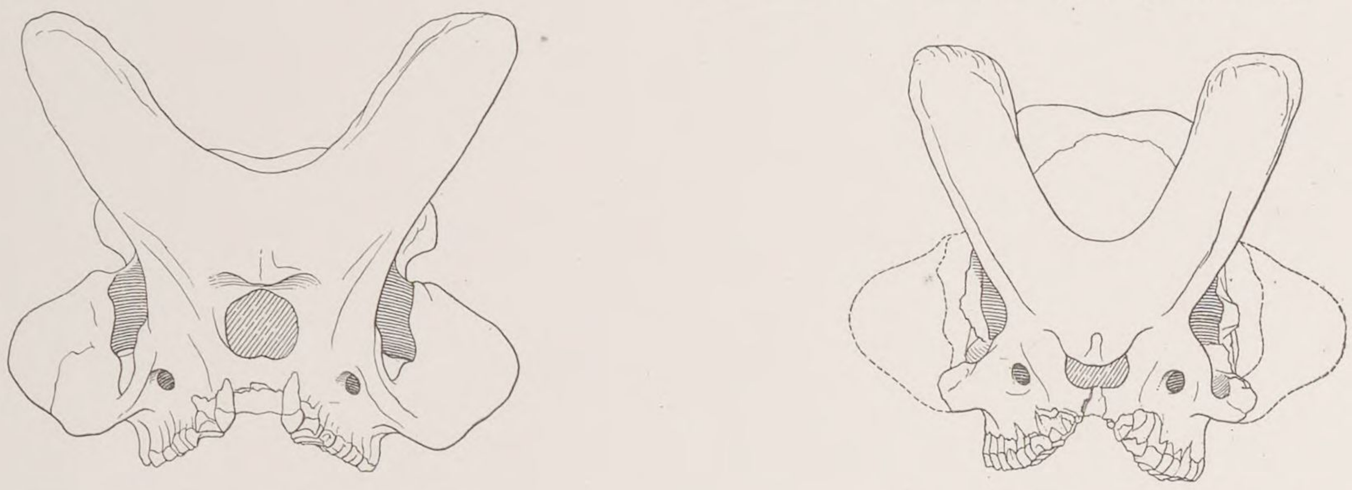
*Titanotherium platyceras.* (No. 1448.) × $\frac{1}{12}$.



*Titanotherium ramosum.* Type. × $\frac{1}{13}$.



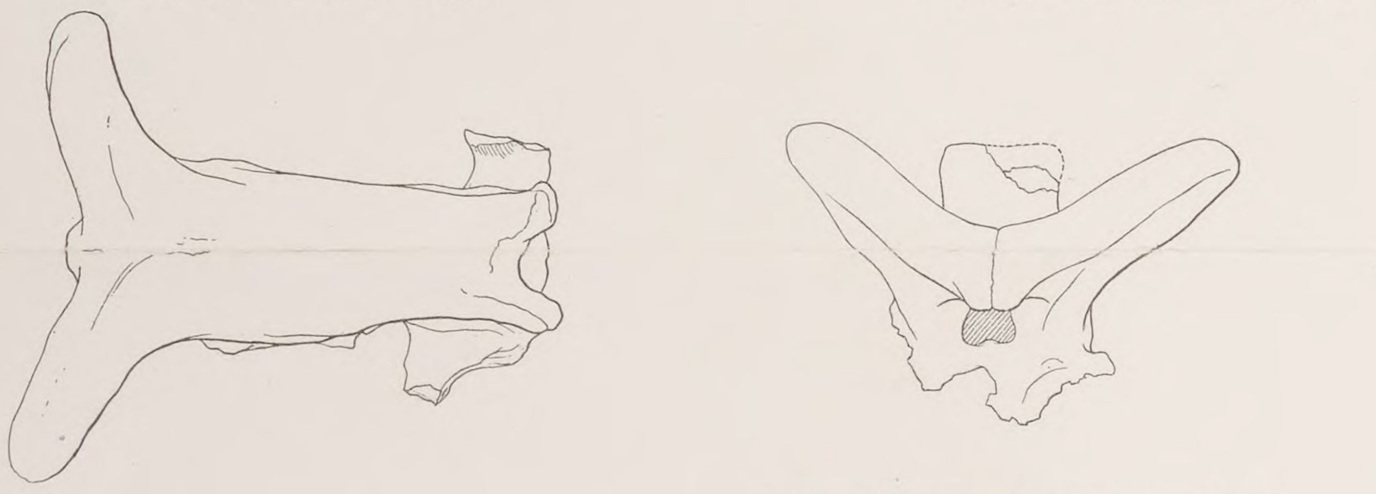
*Titanotherium elatum.* (No. 492.) × $\frac{1}{15}$.



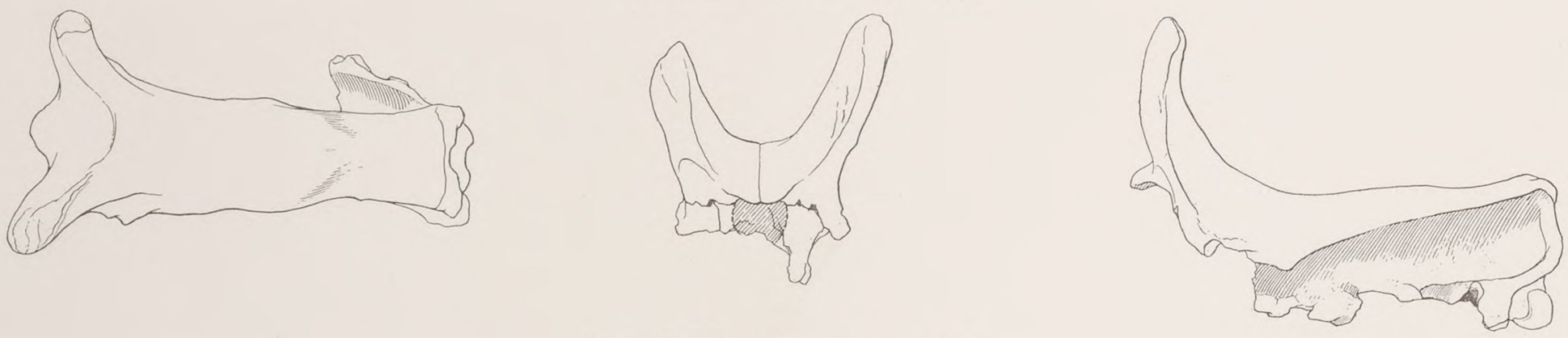
*Titanotherium curtum.* Type.



*Titanotherium elatum.* Type.



*Titanotherium dolichoceras.* Type.



*Titanotherium acer.* Type. × $\frac{1}{14}$.

Superior View. Anterior View. Lateral View.

The Long-Horned Titanotheres.

All figures (excepting *T. dolichoceras*) reduced to the same scale. About one-fourteenth natural size.

# Article X.—A TABLE OF THE GEOGRAPHICAL DISTRIBUTION OF AMERICAN INDIAN RELICS IN A COLLECTION EXHIBITED IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK; WITH EXPLANATORY TEXT.

By A. E. Douglass.

This collection has been gathered by the writer during the last twenty years, and has been arranged in the various special classes irrespective of geographical division, with the design of illustrating the varieties of each class, and solving, as far as possible, the theory of their use by our aboriginal predecessors upon this continent. The importance, however, of the geographical distribution of the objects has not been overlooked, and a special Table has been constructed from the Records, designed to signify the localities whence the several relics were procured.

The writer has been urgently solicited by archæologists who have inspected this work, and whose opinion is of weight, to publish this Table as a compilation likely to be of much benefit to students, and in deference to this request, and in the hope of attaining so desirable a result, it is now, through the courtesy of the authorities of this Museum, presented to the consideration of those engaged in the study of American Archæology.

In forming conclusions based upon this Table a very large caution must be exercised. Common forms, such as arrow and spear points, celts, and many others, are so overwhelmingly abundant, that the collector is compelled to restrict their influx, and their appearance in this Table gives no correct idea of their relative prevalence. On the other hand he has aimed to collect, from every available source, special classes of objects, and the Table will justify conclusions, approximately at least, of their relative geographical distribution. Such classes are Banner Stones, Bird and Bar Amulets, Gorgets, Fleshers, Pestles, Discoidals and Discs, Club Stones, Pipes, Polishers, Drills, Hematites, and others. Many of these classes are capable of sub-

division according to pattern, and are so arranged in the cases, but it has not been thought necessary to express these in the Table. Nor does the Table include some two thousand objects from other quarters of the globe than the American continent, which are found in this collection, the classification of such objects being radically different, and requiring a special enumeration, and, while of great importance in a comparative study of the artistic progress of the earlier races of the world in general, can have little bearing upon the purpose designed by the Table now presented.

The nomenclature adopted by the writer calls for some explanation on his part. When this collection was commenced, some twenty years ago, he found every class encumbered with sundry names varying as the fancy of the collector suggested. Many of these were approved by good authority at that time, but as the science advanced were shown to be based on incorrect or partial knowledge of the uses of the objects.

The *Banner Stone* was termed 'Ceremonial Axe,' 'Ceremonial Weapon,' 'Breast Ornament,' 'Wand,' 'Totem,' 'Mace Head,' 'Mace,' and other names, all sufficiently vague to cause confusion, and some of them applied quite as frequently to other classes of objects, so that, unless the specimen had been figured, one was at a loss to comprehend what class was referred to. When a considerable number of specimens of the Banner Stone class was collected, it was evident that, notwithstanding a large variation in pattern, they possessed certain characteristics common to all, viz. : a single cylindrical perforation along the length or breadth of the plane of the object, with flanges or blades or projections on either side and on the same plane. With more than two hundred specimens before him, it was evident to the writer that the term 'weapon' or 'axe' was not applicable even though qualified as 'ceremonial,' for by no possibility could such a resemblance be shown. As to 'Breast Ornament' that term would only merge this special form among innumerable others widely different in their characteristics, and is therefore not sufficiently distinctive. 'Wand' and 'Totem,' 'Mace Head' and 'Mace,' are liable to the same objection as well as that of being indefinite, and thus the earliest popular designation, that of

'Banner Stone,' seems to be the least objectionable. This name was suggested by its capability of being mounted upon a staff and borne before some dignitary as an indication of rank; and this was for long a favorite theory, and in some cases may have been the fact. Dr. Rau was of the opinion they were worn upon the person, and certain characteristics in many specimens would seem to confirm this notion, but, in the absence of any testimony in history as to their actual use, we prefer to assign the popular designation of 'Banner Stone,' and require all objects so classed to be capable of such use, viz.: possessed of one perforation along the plane of the length or breadth of the object itself.

The patterns of this class vary largely and are grouped, as far as practicable, in the following subdivisions: *Circular*, where the two flanges complete a circle of the whole object; *Battle Axe*, resembling a double-bladed battle axe; *Pick*, a rounded bar, either straight or curved, the ends tapering to a point; *Butterfly*, where the ridge containing the perforation has been cut away at one or both ends, thus resembling a short-bodied insect with over-reaching wings; *Bird Wing*, where the ridges have not been so cut away, and the flanges extend a considerable length; *Triangle Bar*, where the perforation traverses the length of a bar whose vertical section forms a broad-based triangle; *Rectangular*, where the sides and ends are parallel or square; *Conical*, where the flanges diminish in breadth from one end to the other; *Single Arm*, having but one drooping arm, and an oval instead of a circular perforation.[1] In this collection are seven of these rare objects, all beautifully finished, indicating this form to be the deliberate design of the artisan and not a repair of the accidental breakage of a companion arm. *Special*, is the last subdivision of this class, and includes special forms of great variety, freaks or fancies of the artisan, too eccentric to admit of subclassification, but, by conforming to the conditions before specified, entitled unquestionably to rank as Banner Stones.

The class here termed *Gorget* was also invested with an abun-

[1] A fine specimen from the Indian town of Hochelaga is figured in Sir J. William Dawson's 'Fossil Men and their Modern Representatives,' p. 118 (London, 1888), which he regards as an offensive weapon, an idea not confirmed by an examination of other specimens. Also 'Smithsonian Archæological Collection,' p. 23, fig. 92, and Thirteenth Annual Report of the Bureau of Ethnology' (Washington, 1896), p. 123, fig. 145, which is most likely a Single-arm Banner Stone, provided no fracture appears and the perforation is oval.

dance of synonyms. It has been designated 'Pierced Tablet,' 'Bowstring Gauge,' 'Badge,' 'Pendant,' 'Puzzle Block,' and other names founded upon theories of their probable purpose, but the special name here adopted was in use by experts in Indian trade and customs more than a century since, when similar objects in metal and of European make were donated to chiefs or traded to the various tribes, and were substituted for those of stone then worn upon the neck or breast. The Gorget is a plate of stone (generally stratified slate) invariably flat on one side and generally so on the other, the surface highly polished; symmetrical in outline and having one or more perforations through the plate. These perforations, unlike those of Banner Stones, are made with a conical and not cylindrical drill: they are sometimes wanting when otherwise the specimen is complete, presumably from the fact that the boring was left to some other manipulator or was a later process of the original artisan.

It is quite probable that while most of the objects included in the class of Gorgets were purely ornamental, many others may have subserved some industrial purpose. Such uses are as yet conjectural, and until generally determined by later research their intrinsic beauty of form and finish and suitability in other respects appear to entitle the specimens in question to rank as ornamental appendages, and they have been retained in this class.

In this collection we have nearly four hundred objects of this class, whose forms are so varied as almost to defy any attempt at subclassification, and this has been attempted only in the following instances where some common characteristic seems to bring several into line together. The *Spade Shape* is a flat plate of stone, finely polished and of even thickness, semicircular in shape, with a tang of about two-thirds its breadth, extending in form of a square from the upper edge. In this tang or projection are one or two perforations. It differs from Gorgets generally in having this semicircular blade brought to a moderately sharp edge.

It is a question whether this pattern should be included in the Gorget class. Schoolcraft,[1] in the second volume of his Indian

[1] 'History, etc., of Indian Tribes of United States,' Vol. II, p. 89, and plate xliv, fig. 3. Philadelphia, 1860.

Tribes, figures one from South Carolina, and considers it a 'Battle Axe.' Col. C. C. Jones, Jr.,[1] and Dr. Rau[2] both suggest, more reasonably, its possible use as a skin scraper; but that question is still unsettled, and, as an ornamental appendage, it has been here left to its original position as a Gorget. There are six specimens of this subdivision in the collection.[3] Another subdivision is the *Ovate*, comprising all specimens whose ends are symmetrically rounded, though the side outlines may be concave or convex or notched. *Leaf-shaped* includes specimens whose ends are pointed, with similar privilege as to side outlines; *Spear-shape*, where one end is squared and the other pointed; *Square*, where both ends are squared or the general form is of that character; *Ridged*, having the upper surface more or less elevated, sometimes rising to a point; *Expanded centre*, where the specimen is plano-convex in structure, the central portion widened or expanded and then gradually attenuating in width toward the ends, which terminate bluntly. The specimens embraced in these last two subdivisions have two perforations along the central line, which are peculiar in the fact that they are made by a conical drill from the base to the upper surface by one boring only; most other Gorgets show perforations made from both surfaces and meeting midway more or less exactly. There are sixteen specimens of this subdivision in the collection,[4] and they have sometimes been incorrectly called 'boat-shaped,' a term properly applied to objects of entirely different shape and purpose, as will be seen hereafter. As before stated, a large majority of the Gorget class is, from eccentricity of pattern, included under a subdivision of 'special types.'

*Gorgets of Shell*, so called because probably worn in the same manner as those of stone, are subdivided only as *Inscribed* and *Plain*. They number seventeen in this collection.

*Amulets*, so termed, as having most probably some supernatural signification, include *Aztec Amulets*, of jade and other semi-precious stones, occasionally carved and pierced for suspension, and the *Bird* and the *Bar*.

---

[1] 'Antiquities of the Southern Indians,' pp. 289, 290, plate xiv, fig. 14. New York, 1873.

[2] 'Smithsonian Archæological Collection,' p. 25, fig. 96. Washington, 1876. Also 'Twelfth Annual Report Bureau of Ethnology,' p. 245, fig. 150, and p. 383, fig. 263.

[3] From Tennessee, 2; from Mississippi, Georgia, North Carolina and Kentucky, 1 each.

[4] From Ohio, 8; North Carolina, 2; Indiana, 2; West Virginia, Illinois, Georgia, and unknown, 1 each. Six of these specimens, finished in other respects, still want the perforations.

The *Bird Amulet*, as it is here termed, has been fancifully styled 'Knife Handle,' 'Brooding Bird,' 'Corn Shucker,' 'Saddle Stone,' etc. While opinions widely vary as to their use or exact signification, it is still evident that these objects mean to represent a bird, and are best described by the use of that name in conjunction with Amulet. The more complete specimens have a flat base bar, triangular or convex above, with the head and tail of a bird rising at an angle from opposite ends. At each end of the bar a diagonal perforation is made longitudinally through to the base, and is an invariable feature only except where the object may be presumed to be as yet incomplete. Occasionally the tail is wanting, and also the eyes. When the eyes appear they frequently project considerably and expand into a mushroom shape. Among the seventy Bird Amulets in this collection are seven with an expanded oval base, two with the projecting eyes but no apparent head, and one whose head is that of a turtle.[1] All these possess the proper perforations.

The *Bar Amulet*[2] is a bar, square or triangular, with terminal perforations similar to those above mentioned, but having no characteristic of bird or animal. These are rare objects, and seem never to have received a specific name, but the number here shown (38) would entitle them to some special designation, and the peculiar perforations, resembling those of the Bird Amulet, and not found elsewhere, have implied a possible similar signification, and they have been classed as 'Bar Amulets.'

*Implements of Stone*, of *Bone*, and of *Shell*, are divisions which include objects in those materials whose uses are unknown or at least questionable. In arrangement upon the shelves they are separated into patterns or types, which indicate a like use, whatever that use may have been.

Among these subordinate divisions are found sixteen specimens

---

[1] One other instance of the substitution of a turtle's head for that of the bird is reported in the 'American Naturalist,' Vol. XVI, p. 1027, and Vol. XVII, p. 107, both describing the same specimen, found in Miami County, Ohio, in 1881. The one in this collection was found on the Thornton farm, two miles south of Auburn, Cayuga County, New York.

[2] Figures and description of the Bar Amulet appear in Dr. Abbott's 'Primitive Industry,' p. 375, fig. 356, Salem and Boston, 1881; and in Smithsonian Archæological Collection, p. 53, fig. 210. It is much ruder in appearance in Dr. Abbott's figure than usual, the specimens in this collection being remarkable for beauty of form and finish. They vary in length from two to eight inches, and exhibit the characteristic diagonal perforations, which, in a fractured specimen, has been renewed upon the broken end.

of the *Boat-shaped Implement.*[1] It resembles a boat in so many ways that the name seems to sufficiently identify it without designing to imply that such was the idea of the Indian artificer. These objects are from two to seven inches in length, worked to a point at each end, hollowed out more or less deeply, and rounded to a sort of keel below, which is sometimes furnished with a longitudinal groove. It has most frequently two perforations along its axis, running through the bottom of the boat at either end, though three specimens, of great beauty of shape and finish, show no perforations.

The class termed *Celts* is too well known to archæologists to require description here. The form, with more or less modification, prevails throughout the world, but our native product of this implement does not yield in symmetry of form or beauty of finish to the best work of other continents. The synonyms under which it appears in our literature are 'Tomahawk,' 'Wedge-shaped Axe,' 'Hand Axe,' 'Hatchet,' etc. The best authorities in England and America—Sir John Evans[2] and Col. Charles C. Jones, Jr.[3]—prefer to call it 'Celt,' and this term, derived from the old Latin *Celtis*, signifying chisel, has been largely used, and seems less objectionable than the others above named, which imply a hafted implement. When we consider that our aborigines made the grooved axe almost as abundantly as the celt, and were easily familiar with that mode of attachment to a handle, it is inconceivable that they would have expended so much labor upon the smoothing and polishing of the celt without allowing a groove or at least an unfinished section of the surface for the attachment of a handle if they intended to haft it. While hafting may by some urgent necessity have occurred in a few instances, it could not have been a general custom, and a careful examination of some twelve hundred celts, large and small, in this collection, shows but fifteen that give any indication, by groove or local roughening, of having been hafted. A vast majority, by their unblemished and unsplintered edge, imply that they could only have been used for soft work, and when we con-

[1] The Boat-shaped Implements are, from Ohio, 4; Georgia, 3; Tennessee, 3; North Carolina, 2; Kentucky, 1; Mississippi, 1; Arkansas, 1; unknown, 1. *Cf.* 'Smithsonian Archæological Collection,' p. 33, fig. 135, and 'Primitive Industry,' p. 382, fig. 362.

[2] 'Ancient Stone Implements of Great Britain,' Chap. III, p. 50. London, 1872.

[3] 'Antiquities of the Southern Indians,' p. 278. New York, 1873.

sider the abundance of garments made from skins recorded by early historians, and how these were prepared, and also the mode of excavating canoes from tree-trunks by successive burnings and chiselling of the charred wood, both of these extensive industries implying hand-use, it seems but reasonable to adopt a designation as little confusing, as regards suggesting any other mode of use, as the one here given to this implement.

The class termed *Flesher* is an implement resembling in some respects the celt, and most generally so called, but it is plano-convex in structure, and that form appears most suitable for flaying or skinning animals, from which it has been termed 'Skinner' and also 'Bark-peeler,' which purpose it also answers. The lower surface is flat, slightly curving upwards as it approaches the edge where it meets the upper and convex surface. There are thirty-five specimens of this implement.

*Gouges* and *Adzes* are terms well understood, and these implements appear to have been used by the Indian in the same way as our metal tools of the same name at the present day, while they possess those familiar shapes. The Gouges in some cases indicate, by knobs upon the back, that they were to be hafted, and the Adzes, also knobbed, have occasionally a gouge-like, cutting edge.

The term *Chisel* is applied to bars of stone, long and slender, both square and round, tapering at one or both ends to a sharp cutting edge. They are subdivided into 'Square,' 'Round,' and 'Flat,' this last representing very thin elongated celts, which must have subserved such a purpose.

The *Grooved Axe* is one of the common well-known Indian implements which needs no description. Although a few specimens have been found in Europe, they are there so exceedingly rare that they may be considered peculiar to the continent of America. In this collection there are 419 objects of this kind, varying from 14 inches in length and of 17 pounds weight, to the size of a child's toy only 1¼ inches long, probably merely ornamental. They are generally finely made, though those from New England are mostly of rude form and extremely flat and broad. The groove at times entirely encircles the blade, but frequently is wanting upon the edge next the handle, where the

surface is left flat, or slightly concave, presumably to permit the insertion of a wedge and thus tighten the withes when slackened by continuous use.

The *Grooved Maul* is often simply a grooved axe deprived of its cutting edge by fracture or grinding. The larger ones are frequently natural pebbles or boulders, grooved about the middle for hafting. They answered the purpose of our sledge hammer when of considerable size and weight. The smaller sizes no doubt were hafted and covered with skin, leaving only one striking face exposed, and thus answered for a weapon in war, or the chase of the larger wild animals.

*Hammer Stones* are almost universally oval or disc shaped pebbles, of small size with slight depressions in the centre of each side for the better grasp of thumb and finger. The bruised edges indicate their mode of use.

*Anvils* and *Cupped Stones* comprise a series of stone blocks, generally boulders, which have upon their surface one or more depressions about an inch in breadth and depth, supposed to be for breaking walnuts or for grinding paints or for sockets for reed drills. A generally bruised surface indicates their occasional use as 'Anvils.' They have been styled 'Nut Stones,' 'Spindle Rests' and 'Paint Cups,' suggested by these possible uses.

*Pestles* are rounded bars of stone used in mortars of stone or wood for crushing grain. They are frequently carefully made, tapering toward the handle end, which terminates in a knob. Their length in this collection varies from two to thirty-three inches, the smaller ones being frequently natural pebbles of suitable form. This elongated bar seems to have been peculiar to the Northern Atlantic States. West of the Alleghanies and to the Rocky Mountains the Pestle was from four to eight inches in length, and expanded to a much broader and flat base in which appears a small central depression. Beyond the Rockies to the Pacific Coast, the Pestle is generally from eighteen inches to two feet in length, capped with a well-carved knob, and gradually enlarging thence to the other extremity. The three subdivisions of this class are therefore 'Round Bar,' 'Bell-shaped' and 'Knobbed,' representing these several forms.

*Mortars* are either rude or dressed masses of stone, more or

less depressed upon one surface for receiving grain or other material designed to be crushed.

*Picks and Hoes* comprise an extensive series of agricultural implements of chipped chert, largely from the Mississippi Valley. They are long, narrow, and rather thick blades, from three to eight inches in length and one to four in breadth, sometimes with parallel sides and rounded at the ends, and on all sides trimmed down to a rude edge, or again wide at one end which is slightly pointed, and diminishing gradually toward the other. One end generally shows the brilliant polish effected by long use in a soft soil. The term 'Picks' is applied to the narrow implements of this class, presuming they have not been used so much for lifting or removing soil as for making holes to receive seed. The 'Hoes' indicate by the breadth of blade their probable use as named, while a subdivision is that of 'Notched Hoes,' which are blades of thin chert nearly circular in shape, on one extremity of which are two deep notches affording hold for a withe or cord, by which a handle may be attached against the face of the implement, much resembling hoes in present use. These notched hoes are extremely rare, and, so far as known, are only found in southern Illinois, eastern Missouri and west Kentucky. In this collection are thirteen specimens, varying from four to seven and a half inches in greatest diameter. They are of brown chert, and the polish of the lower edge indicates a prolonged use.

Much larger implements, used much in the same way are classed as *Spades*. These are generally long, oval shaped slabs of chert, flat on one surface and convex on the other, ranging from a length of eight inches and a breadth of four, to that of fifteen and a breadth of five. There are other exceptional forms, principally fan shaped, and all indicate a considerable use by a brilliant polish upon the edge. Though it is possible to use them as hand implements for one or both hands, it is not unlikely that they may have been fitted to a handle and used as our shovel of the present day.

The term *Discoidals* was found by the writer in general use, and as it simply identified a shape without implying a use possibly questionable, it seemed proper to adopt it. Objects having the character of discs vary so greatly in size that it seemed more convenient to make a division into two classes, one of 'Discoidals,'

embracing those having a diameter of three inches and over, and one of 'Small Discs' and 'Spindle Whorls' including those of a less diameter. The class of Discoidals therefore includes the objects commonly known as 'Chungkee Stones,' and the probabilities are that most all so classed in this collection—while possibly having in some cases had a secondary use as mortars—were designed for use in the game of Chungkee or its like. A Discoidal is a circular wheel or disc of stone from three to eight inches in diameter, and from one to one and a half inches in extreme or marginal thickness. The specimens are of various kinds of stone, frequently of white or yellow quartz, and are of remarkable beauty of finish. The subdivisions are, the 'Convex,' the sides of which are slightly convex; the 'Concave,' deeply hollowed on both sides; 'Concave Pitted,' having in the centre of each concavity a slight depression, which is sometimes placed upon an elevated point in the centre of the hollow; 'Concave Pierced,' where the centre is perforated; 'Bevelled Edge,' discs with plane surfaces, and edge slightly bevelled, as described by Le Page du Pratz[1] in referring to the game as played in Louisiana. All the specimens in this subdivision, seventeen in number, come from States south of Virginia and Kentucky. The surfaces are not pitted. The 'Cheese Form' is the last subdivision, and seems so unsuitable for use in the game of Chungkee, or perhaps any game whatever, that it might be considered as a distinct class. These objects are cylindrical forms of stone, equal in height and width, ranging from three by three inches to six by six, and slightly convex on the ends. Of the fourteen specimens in this collection[2] several show traces of exposure to fire, and this with their suitability for such a purpose, suggests the possibility of their use as pot-rests.

*Small Discs* include all disc-shaped objects less than three inches in diameter. They comprise as subdivisions, 'Bevelled' (sometimes called 'Bung-shaped') discs, having a bevelled edge, shading gently into the lower surface, which is slightly convex, while the upper surface is flat and comes sharply to the upper side of the bevelled edge. They resemble the bung of a large cask. They are quite abundant in western North Carolina and eastern

[1] 'Histoire de la Louisiane,' Vol. III, p. 2. Paris, 1758.
[2] Tennessee, 9; New Jersey, 3; North Carolina, 2.

Tennessee, and may fairly be presumed to have been mullers or crushers of some sort. Another subdivision of this class is that of 'Spindle Whorls.' These are flat or slightly concave discs perforated through the centre. While this fact would imply most naturally such a use, it is possible that several of them may have been buttons for games. Certain marks on several would seem to indicate a value as objects for play. While a large majority are of stone, others are of earthenware chipped into shape. Another subdivision is that of 'Simple Discs,' imperforate, with flat or convex, or concave surfaces. Most of these were probably used for games, and those with concave surface possibly as paint cups. They range from one-half inch to two inches in diameter.

Passing by several classes whose titles do not require elucidation, we have that of *Club Stones*, of which there are 17 of stone, and 21 of iron ore. These are egg-shaped objects with the small end flattened or hollowed for attachment to a staff or handle by a casing of skin. Eighteen of those of hematite or other iron ore are strongly magnetic, and would almost suggest an Indian's knowledge of this property, though their great weight in small compass was probably the reason of their selection. They are remarkably symmetrical in shape, notwithstanding the labor required to work such obdurate material.

The class designated *Tubes* and *Perforated Stones* includes a large variety of implements or ornaments, tubular in shape, and destitute of the flanges or wings which would bring them within the class of Banner Stones. Of the subdivisions the 'Hour Glass' is a well-known pattern, resembling two slender cones united at their apices, encircled there externally by one or two raised bands, and excavated throughout in corresponding shape. Of these there are seven specimens. The 'Cylindrical' subdivision includes all round perforated rods, sometimes of slightly expanding diameter towards one end, from two to twelve inches in length, and frequently highly polished. The 'Flat Base' is another subdivision, having one side slightly flattened and resembling large beads. These are generally of stratified slate, and are finished with great care and delicacy.

*Pipes* constitute a very extensive class in this collection, numbering in all some 375 specimens. Every collector will appreciate

the difficulty of determining, with any approach to accuracy, the age of such objects. Before and since the advent of the European, the fabrication of pipes has been a continuous industry, and while Indian tribes exist, cannot be expected to cease. Pipes made by the white man for purposes of trade, and on patterns that suit the barbaric taste of the Indian, also intrude and intermingle with those of native handiwork. This is not so likely to be the case with pipes made of the harder stones as with those made of steatite or earth or clay; but the Indian artisan of the Post-Columbian period has gained expertness from contact with the skill of the European and familiarity with his tools, and emulates him in the grace and elegance of his productions. So it follows that specimens of fine work may be the product of the enlightened Indian of the last three centuries, and thus the question of pre-historic origin will need to be determined by the facts regarding the *provenance* of the specimens under consideration. To obtain this information is extremely difficult and often impossible, as every collector knows. Specimens have often passed through many channels, from the finder to the collector, and from one cabinet to another, until their pedigree has been lost. Most of the pipes in this collection, however, have a well-established record, from which their Pre- or Post-Columbian origin may be argued. Among the latter are a few clay pipes of English and Dutch make, having manufacturers' marks, and taken from Indian graves in New York and Pennsylvania, which have a value in determining the date of an interment. The subdivisions of this class are as follows:

| | | |
|---|---|---|
| Human Sculpture | Pipes bearing human head, face or form | 30 specimens. |
| Bird Sculpture | Pipes bearing bird's head or figure | 23 " |
| Animal Sculpture | Pipes representing animals or reptiles in whole or part | 39 " |
| Platform Pipes | Bowls set on broad thin plates, pierced for stem | 12 " |
| Shield Pipes | Bowls with shield to be pressed to lips without stem | 6 " |
| Tubular Pipes | Bowls and stems in same plane or direction | 21 " |
| Trumpet Shape | Bowls flaring and long tapering stem | 13 " |
| Solid Bowl | Bowls with aperture in same for stem | 46 " |
| Double Bowl | Two bowls on one shaft or stem | 2 " |
| Double Stem | Bowl with two or more stems | 4 " |
| Right Angle | Bowl at right angle to stem | 103 " |
| Obtuse Angle | Bowl at obtuse angle to stem | 39 " |
| Foreign | British and Dutch pipes found in Indian graves | 13 " |
| Unclassified and fragmentary bowls and stems | | 24 " |

These subdivisions were adopted some years since at the suggestion of a friend who had made a special study of pipes, and contributed largely and learnedly to our literature on the subject. As will be seen, some prominent characteristic has given the name to each subdivision, and, when these are wanting, the 'Tubular' or 'Right Angle,' or 'Obtuse Angle,' include the remainder only, notwithstanding the fact that the first four divisions may comprise right or obtuse angle or tubular pipes. In the absence of any other known subdivision applicable to a class so numerous, and of such infinite variety in type, this system of subdivision has been retained, although perhaps not as satisfactory as could be desired.

The class of *Whetstones* includes all stone objects, large or small, whose form or surface gives indication of having been used for grinding, sharpening, or smoothing implements of stone or wood, and is subdivided into 'Hones' and 'Arrow-smoothers,' the latter having the surface furrowed, presumably for that purpose.

*Polishers* is the title given to a large number of stone objects probably used for polishing or rubbing skins or burnishing pottery. They are subdivided as to form into 'Square,' 'Oblong,' 'Conical,' and 'Natural Pebbles.' The latter necessarily must give some evidence of having been so used. They are generally carefully and symmetrically finished, and of the finer-grained stone.

*Pendants*, *Plummets* and *Sinkers.* This is a conglomerate class, including a great variety of objects, ornamental or useful, evidently susceptible of suspension. They are made of stone, of hematite and shell, and exhibit every kind of finish, from the finest and most symmetrical carving and shaping, to the rudest sort of adaptation by grooving a flake or pebble. The subdivisions of this class are 'Pendants' and 'Sinkers.' The former is used in a restricted sense, and implies a use as an ornament for the person. It is a round or cylindrical or pear-shaped bar, furnished with a groove or perforation at one end for suspension. It is sometimes banded with one or two rings in relief at one or both ends. So many ornamental objects of Indian make are pendant upon the person, though ranking as Gorgets, or in other

classes according to their characteristics, that the term Pendant, as here used, is restricted to such objects as comply with the above description. The other subdivision, that of 'Net-Sinkers,' includes a large assortment of stone and shell pear-shaped objects, grooved or perforated at one end, mostly obtained from the surface of Florida shell-mounds; also stone masses of oblong or spherical form or egg-shape, encircled with a groove or pierced at the head, all of which possibly have been sinkers for nets in fishing, and forcibly suggest that use.

*Natural Pebbles* and *Balls* include a large number of symmetrically-shaped pebbles, found in Indian mounds, and serving the purpose of games of some sort, or valued for their form, with possibly a superstitious veneration.

*Paint-cups* are a series of very small cups or mortars, supposed to have been so used, made both of stone and earthenware.

*Limonites* are pebbles of this well-known mineral, selected apparently for their beauty of form. Many of them might have been used as paint cups, though generally too small to have been of service in that way. These have been gathered from mounds, as has also the class of *Mound Relics*, etc., which covers a mass of indiscriminate material, including fossils and concretions of ore and stone.

The following classes, *Beads of Bone*, *Stone*, *Shell*, *Glass*, sufficiently explain themselves. It should be observed that the numbers in the Table do not always indicate the number of the beads, which would otherwise amount to several thousands. Of the larger beads it occasionally expresses the number, but those from Florida mounds as often in compact masses incapable of separation, and with a vast quantity from Central New York, are only numbered by lots or parcels, and the same may be said of the strings of Wampum. In this case, as well as in those cases which have been previously excepted (Celts, Grooved Axes, Arrow and Spear-points), the Table affords no opportunity of estimating the relative prevalence of these objects.

The class of *Arrow Heads* is exceedingly numerous and of great variety of form. The name is given to all such objects as do not exceed two and a half inches in length. The subdivisions of this class are, 'Tiny,' being less than one inch in length;

'Small,' from one to one and a half inches in length ; 'Medium,' one and a half to two inches ; 'Large,' from two to two and a half inches. On the shelves these subdivisions are again arranged according to pattern, viz. : 'Triangular,' 'Lozenge-shape,' etc.

*Spear Heads* includes all spear-shaped objects exceeding two and a half inches in length. The subdivisions are : 'Small,' from two and a half to three inches ; 'Medium,' from three to four inches, and 'Large,' over four inches in length. These subdivisions are again arranged as to pattern, as in the case of Arrow Heads, such as, 'with or without Tangs,' 'Barbed and Unbarbed,' 'Lozenge-shape,' 'Triangular,' etc. It must be borne in mind that the names 'Arrow' and 'Spear' are applied to these objects from the white man's point of view rather than from that of the Indian. Many of the large Arrow Points were used as knives, scrapers and perforators, while the Spear Points, with very rare exception, must have been used as knives, considering the fact that Javelins or Lances were almost entirely unknown among the savages at the time of the advent of the European ; and it may also be observed that probably these chipped implements were turned out from the Indian workshop notched or tanged and ready for conversion into any state which the possessor or purchaser might desire ; that in fact these appendages constituted their normal condition, without regard to the use to which he might desire to apply them. The name 'Spear Point' has, however, become so universal for chipped implements apparently adapted to that use, that it does not seem desirable nor indeed possible to displace it by any other appellation. Several specimens of this class reach twelve inches in length, and one measures fifteen and a half inches.

*Drills* or *Reamers* are a class of flint or chert chipped implements designed to perforate any material by turning or punching. They number 327 in this collection, and in many cases retain the tang and barb belonging to the spear and arrow head from which they have frequently been fashioned. The subdivisions include the 'Double-end,' viz. : long and slender bars finished with the greatest care and pointed at both ends. 'Needle-point,' a beautiful and delicate point one-quarter of an inch in length upon the apex of an arrow-point, designed no doubt for fine thread-

work upon moccasins or belts. Six of these latter objects in this collection are probably unique. 'Pipe Drills,' long, flat bars, gradually broadening from point to butt, slightly concave on the sides, suitable for boring the stems of the massive stone calumets. One of this kind may be considered as unique, since the butt is furnished with a semi-elliptical blade with symmetrically rounded edge, suitable in shape to finish off the hollow of the pipe-bowl after being rudely excavated.

*Scrapers* is a class of small chipped flint or chert implements, no doubt used as the name implies. They are generally thin blades or discs worked to a sharp edge, and frequently show the notches peculiar to arrow and spear points, not for the purpose of hafting, but from being shaped from the normal forms before mentioned, or from arrow or spear points injured by fracture. These latter are subdivided as 'Notched'; the circular as 'Disc'; while others, with length exceeding breadth, and chisel-ends, are named 'Elongated.' These implements were indispensable adjuncts to the Indian artisan's stock of tools, and are exceedingly abundant, this collection including more than a thousand specimens.

*Ornaments of Stone and of Bone* are classes presenting such varieties of pattern as to be incapable of subdivision. They are mostly pendant in character, and very finely and delicately finished in attractive material.

*Ornaments of Shell* are of a like variety, and have a partial subdivision of 'Hair Pins' and of 'Engraved Discs.'

Recurring again to chipped implements, we have the class termed *Knives*, comprising all implements of stone which have generally been so named from the likelihood of their having served the Indian in that capacity. The subdivisions are: 'Ovate' or elliptical, 'Leaf-shaped,' long, narrow and pointed at both ends, and sides convex; 'Spear-shaped,' having parallel sides but one end pointed, the other square or slightly concave; and 'Semilunar,' a half-moon in shape, not chipped but rubbed smooth, and furnished occasionally with a ridge or rim along the upper margin for the better grasp of the hand. All the blades of this class are chipped down to extreme thinness, and the 'leaf-shaped,' in several specimens, exceed six inches in length by

three in breadth, one specimen being eleven inches by three in dimensions. This implement was quite as indispensable in the Indian life as the scraper, and the number in this collection is therefore very large, being nearly five hundred.

*Flake Knives* are unworked flint or chert or obsidian flakes, as struck from a core, and serving such a purpose. Excepting in States where obsidian is abundant, they are a somewhat rare object on this continent.

*Flakers*, or flaking tools, is the name given to short, thick rods of chipped flint or chert, presumably used in the process of chipping other flint implements. This term is applied by Sir John Evans (p. 369 of 'Ancient Stone Implements of Great Britain') to similar objects which he conceives to have been so used. They are about the size of a finger, are not cores, but have been chipped into shape with care and precision. In length they vary from two to four inches, and, so far as this collection is concerned, appear only in Missouri.

*Cores* and *Nuclei* are the blocks of chert, flint or obsidian from which, as their surface indicates, flakes have been struck. When of chert or flint they appear here only from Missouri, and when of obsidian mostly from Mexico and Central America. Their scarcity in the United States may be attributed to the collector possibly regarding them as worthless, but they are very rare in collections generally.

*Bunts*[1] is a term applied to flints shaped into convenient forms for storage or transportation, but as yet unformed as finished implements. The name has been used more than fifteen years, and comes to this collection from the previous owner of objects from Missouri which the writer secured by purchase more than ten years since. It served to particularize a series of flint blocks worked into merchantable shapes, to which no specific name had been given, and, though of itself not suggesting any characteristic

[1] Mr. John P. Jones, of Keytesville, Missouri, adopted this word 'Bunt' about twenty years ago. In 1880, when the writer acquired that collection, for the reasons above given, the name was retained in the same sense as employed by Mr. Jones. In 1878 it was used by Dr. Haldeman ('Am. Antiquarian,' Vol. I, p. 79) as a synonym for the blunt Arrow Head, and recently in a like sense, by the writer on 'Stone Art' in the 'Thirteenth Annual Report of the Bureau of Ethnology,' 1891–92, p. 168. It does not appear as a dictionary word in any archæological sense, direct or implied, and its selection seems to be purely arbitrary. It would be interesting to know whether any other mention has been made of the word as an archæological designation, and whether Mr. Jones has not a prior claim to the use of the term 'Bunt' in the sense here employed, which certainly supplies a long-needed want in our nomenclature of Indian relics.

or quality of these objects, was yet so comparatively an unused word as to permit it to be adopted here, without conflict with any meaning otherwise likely to be confusing. The name has only been here applied to the Missouri specimens, other objects of the same class having been previously included among 'Implements of Stone.'

*Shell Calabashes* are, as the name implies, drinking vessels made from the large conch, by cutting out the columella, and trimming the edge to suit. They are from Florida sand mounds.

*Ornaments of Gold and its Alloys* include a large series of those objects, exhumed from Huacas, in South America, and a single one from the peninsula of Florida. They are massive nose and ear labrets, figures of gods, necklaces and rings, beads, hair pins of gold, more or less pure, and number 155 specimens.

*Bronze Ornaments* and *Implements* are objects in that material from Mexico and Peru.

*Quippus* and *Cloth* are from Peru.

The title *Flageolets and Whistles* comprises four of the former (from Mexico), and five of the latter from a Missouri mound. These whistles, made from limonites of pear shape, from which the clay core has been extracted, and the orifice trimmed to a sharp edge and perforated for suspension, are believed to be unique.

The next series is that of *Aztec Stamps* and *Seals*, of which there are 51 specimens, all from the valley of Mexico. They represent designs and patterns of great beauty, as well as figures of gods and animals, and are supposed to have been used for decorating the person in colors for public festivities.

*Copper objects* includes a moderate display of objects in that metal beaten into shape, and occasionally ornamented with raised figures. These objects have been subdivided into classes corresponding with those in stone, which they resemble. They are principally from Ohio.

The collection now under consideration closes with a most extensive and varied series of objects in *Hematite* and other *Iron Ores*. They number in all about eleven hundred specimens, of which about 1050 are in red hematite, and the balance in the brown hematite and other ores of iron. This is believed to be

the largest single collection of hematite objects in the country, and shows conclusively the appreciation of the Indian for beauty of form and symmetry in proportion, and that he spared no labor in expressing this feeling in the hardest and most obdurate material. These specimens appear to radiate from three great centres, viz.: West Virginia, southeastern Ohio, and central Missouri, and thence extend in diminishing frequency into the adjacent States. The subdivisions are, the natural nodules or 'Mineral Lumps,' the 'Paint Lumps,' whose surfaces show evidences of rubbing to obtain the paint so common among the tribes from Florida to the north and west; 'Balls and Hammer Stones,' shapes worked from the most obdurate ore; 'Grooved Axes,' from an ounce to eight pounds in weight, the largest being exquisitely polished; 'Celts and Cutters,' from half an inch to seven inches in length; 'Grooved Plummets and Sinkers'; a large number of 'Burnishers' of very varied shapes, and 'Pear-shaped Pendants,' finely proportioned, which may have been ornaments and yet possibly weights for weaving.

A few words upon the arrangement of this collection seem to be called for before concluding this article.

The purpose of the writer has been so to arrange the various specimens of presumably prehistoric Indian work as would enable the student of American Archæology to determine with the least labor to what class and subdivision of that class any object in his possession properly belonged, and by comparative study of the specimens in that class, to decide how they were used. For general anthropological purposes, a geographical arrangement seems to be most desirable and should by no means be disregarded. But in the study of special classes, the latter mode of arrangement presents the difficulty of accurately comparing characteristics when the specimens are scattered in small parcels through numberless cases in an extensive museum, and mingled with vast quantities of miscellaneous matter to which they have no sort of affinity, and which distract and confuse the observer. It seemed therefore desirable, that at least one collection should, in a circle of great educational centres, be arranged in this manner, and serve as a standard for all questions of classification throughout

that circle. These centres might be New York, for New England and North Middle States ; Washington for Southern States, and Chicago for the West. It must be obvious to all that the nomenclature of Indian Relics is at present in a very confused state. The names given by collectors and essayists to the objects they describe render it quite impossible, without a figure, to conceive the nature of those objects. In the present collection not only are the classes and their variations segregated as described, but a fixed nomenclature has been adopted based on the best authorities in American Archæology, except in a few instances where a more thorough study and later developments have shown the older designation to be erroneous. Hardly anything is so perplexing in the reports of field explorers as the names given to objects of their find, without a figure to guide the reader, nor is it more satisfactory to the student to read admirably illustrated essays emanating from sources of conceded high authority, where palpable misnomers are applied to the objects figured, and involve him in a sort of hopeless bewilderment.[1] A point in our knowledge of American Archæology has surely been reached when this matter of nomenclature could and should be definitely settled, and perhaps this could most effectually be accomplished by a committee appointed at an annual meeting of the American Association for the Advancement of Science, selected from the Section on Anthropology, who should consider the subject and report their conclusions at the next annual meeting of the Association.

As the Association includes members from our most prominent museums most capable of determining such questions, their con-

[1] A very able, interesting and instructive essay upon 'Stone Art,' in the 'Thirteenth Annual Report of the Bureau of Ethnology' (Washington, 1896), displays a series of misnomers exceedingly confusing to the reader. They occur between pages 121 and 125. Figure 135 is not 'Boat Shape' but a Gorget with 'expanding centre.' Fig. 136 is not a 'Gorget.' It is represented in this collection by seven specimens. resembling the longitudinal half of an ordinary peg-top, and never perforated, but with or without a groove at one or both ends. They are all from Ohio, and would be termed 'Pendants' or 'Plummets.' Figs. 137 and 138 are unquestionably 'Boat Shaped Implements,' not 'Banner Stones.' Fig. 139 is not a Banner Stone nor 'Reel Shape,' but a 'Pendant.' Fig. 140 is a Banner Stone, though it does not comply with the description in the text. Fig. 141 is a Banner Stone of 'conical' outline and not 'crescent.' Figs. 142 and 143 are Banner Stones of 'Butterfly' pattern and not 'crescent.' Fig. 144 is a Banner Stone, 'Reel-shape' and not 'Butterfly.' Fig. 145 is possibly a 'Single Arm' Banner Stone, provided no evidence appears of fracture of a companion arm. Fig. 147 is a Banner Stone, 'Curved Pick' pattern, and in no sense 'Boat Shaped.' Fig. 148 is also a Banner Stone, of 'Semilunar' pattern and not a 'Boat Shape.' Fig. 150 is a Banner Stone of the 'Pick' pattern. Fig. 149 is a Banner Stone of the 'Bird Wing' pattern, and not a 'Pendant.' It is quite unaccountable how such errors should have crept into an otherwise valuable contribution to our literature on Indian Art on this continent.

clusions would carry decided weight and relieve the student from much that is at present annoying confusion and perplexity, to say nothing of supplying a satisfactory basis for the records of field exploration.

# Table Showing the Geographical Distribution of American Indian Relics in the Collection of A. E. Douglass, American Museum of Natural History, New York.

| Classified Objects. | Banner Stones. | Stone Gorgets. | Shell Gorgets. | Quoits. | Aztec Amulets. | Bar Amulets. | Bird Amulets. | Implements of Stone. | Implements of Bone. | Implements of Shell. | Celts. | Fleshers. | Gouges and Adzes. | Chisels. | Grooved Axes. | Grooved Mauls. | Hammer Stones. | Anvils and Cupped Stones. | Pestles. | Mortars. | Picks and Hoes. | Spades. | Discoidals. | Small Discs and Spindle Whorls. | Vessels of Pottery. | Vessels of Stone. | Images, Masks and Heads. | Club Stones. | Tomahawks. | Tubes and Perfo'd Stones. | Pipes. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *UNITED STATES:* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| East of Rocky Mountains | 12 | 15 | | 2 | | 1 | | 5 | | | 60 | 4 | 5 | 2 | 41 | 1 | 6 | 2 | 16 | | 1 | | 5 | 4 | 1 | | 4 | | | 1 | 15 |
| New England | 4 | 2 | | | | | 1 | 1 | | | 7 | | 14 | 9 | 7 | 1 | 1 | | 6 | 1 | | | | | | 2 | | | 1 | | |
| Maine | | | | | | | | | | | | | 1 | | | | | | 1 | | | | | | | | | | | | 1 |
| New Hampshire | 1 | 1 | | | | | | | | | | | 7 | 1 | 2 | | | | 1 | | | | | | | | | | | | 2 |
| Vermont | | | | | | | 1 | 1 | | | 2 | | 1 | | 1 | | | | 1 | | | | | | | | | | | 2 | 2 |
| Massachusetts | 2 | 1 | | | | | 2 | | | | 8 | | 26 | 5 | 10 | 1 | | | 10 | | 1 | | | | | | | | 2 | | 1 |
| Rhode Island | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Connecticut | | 1 | | | | | | | | | 2 | | 5 | | 3 | | | | 3 | | | | | | | | | | | | 1 |
| New York | 5 | 20 | | | | 1 | 16 | | 17 | | 85 | | 16 | 83 | 2 | 1 | 16 | | 54 | | 8 | 1 | | 1 | | 1 | | | 1 | | 43 |
| New Jersey | 4 | 2 | | | | | | | | | 1 | | 2 | | 4 | | | | 2 | | 1 | | | 3 | 1 | 4 | | | | 2 | 1 |
| Pennsylvania | 5 | 1 | | | | | | | | | 4 | | 3 | | 5 | | | | 1 | | | | | | | | | | | 3 | 10 |
| Maryland | 1 | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | 2 | | | | | | 2 |
| Delaware | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| District of Columbia | | | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | | | |
| Virginia | 2 | 1 | | | | 1 | | | | | 11 | 1 | | | 3 | | | | | | | | 1 | 1 | | | | | | 1 | 4 |
| West Virginia | 2 | 21 | | | | 1 | | | 4 | | 90 | 8 | | 6 | 6 | | 8 | 2 | 4 | | 2 | 1 | 1 | 21 | | | | | | | 22 |
| Kentucky | 9 | 6 | 3 | 8 | | 1 | | 1 | 1 | | 19 | 1 | | | 17 | | 1 | 1 | 10 | | 2 | 2 | 7 | 26 | | | | | | 2 | 21 |
| Tennessee | 3 | 6 | 4 | | | | 1 | 4 | | 1 | 3 | | | 1 | 1 | | 1 | | | | | | 36 | 28 | | | 2 | 1 | | 3 | 39 |
| Ohio | 100 | 213 | 4 | | | 22 | 35 | 14 | 1 | | 95 | 20 | | 15 | 31 | 3 | 18 | 5 | 12 | | 3 | | 4 | 3 | | | | 1 | 1 | 45 | 40 |
| Indiana | 11 | 14 | | | | 2 | 1 | | | | 10 | | | | 8 | | 4 | | 5 | | | 1 | | | | | | | | | 11 |
| Michigan | 15 | 32 | | | | 6 | 10 | 4 | | | 4 | | 1 | 1 | | 2 | 1 | | 2 | | | | | | | | | 1 | | 1 | 3 |
| North Carolina | 13 | 3 | | | | | | 3 | | | | | | | 2 | | 1 | | 1 | | | 1 | 17 | 38 | | 1 | 1 | 4 | | 6 | 24 |
| South Carolina | | 2 | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | 3 |
| Georgia | 3 | 5 | 5 | | | 3 | 1 | 5 | | | 3 | | | 2 | 1 | | | | | | | 1 | 16 | 16 | | 1 | | 2 | | 4 | 34 |
| Florida | 9 | 2 | | | | | | 2 | 2 | 14 | 61 | | | | | | 3 | | 1 | 1 | | | | | 9 | | | 1 | | | 3 |
| Alabama | | 1 | | | | | | 1 | | | | | | | | | | | | | | | 2 | 2 | | | | | | 1 | 2 |
| Mississippi | 1 | 2 | | | | | | 1 | | | 1 | | | | | | | | 2 | | | | | 3 | 1 | | | | | | |
| Louisiana | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Texas | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arkansas | | | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Missouri | 1 | 5 | 1 | | | | | 14 | | | 170 | 1 | | 12 | 258 | 25 | 20 | 1 | 6 | 7 | 156 | 20 | 9 | 14 | 15 | | | 5 | | 1 | 24 |
| Illinois | | 1 | | | | | 2 | 3 | | | 7 | | 1 | 5 | 6 | | | | | | 10 | 18 | 5 | 1 | 1 | | 1 | | 1 | | 6 |
| Iowa | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 3 |
| Wisconsin | 1 | | | | | | | | | | 3 | | | | 1 | | | | | | | | | | | | | | | | 6 |
| Minnesota | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 |
| Kansas | 1 | | | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | | | | | 2 |
| Nebraska | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Wyoming | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | |
| Dakota | | 2 | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 6 |
| California | | | | | | | | 1 | | | | | | | | | | | 5 | 2 | | | | | | 1 | | | | 1 | 6 |
| Oregon | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 3 |
| Washington | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 3 |
| Montana | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| Alaska | | | | | | | | | 5 | | 2 | | | | | | 1 | | | | | | | | | | | | | | 1 |
| Colorado | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Utah | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| New Mexico | | | | | | | | 2 | | | | | | | 3 | | | | | | | | | | 101 | | | | | | 2 |
| Arizona | | | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | |
| Idaho | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| Nevada | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *NORTH AMERICA:* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Canada | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | 1 | | | | | | | 1 |
| British Columbia | | | | | | | | | | | | | | | | | | | 2 | | | | | | | 1 | | | | | 2 |
| Mexico | | 1 | | | 70 | | | 3 | | | 3 | | | | 2 | | 1 | | 1 | 1 | | | | 39 | 1 | | 34 | | | | 6 |
| Central America | | | | | | | | 1 | 2 | | 34 | | | 3 | | | | | | | | | | | | | 31 | | | | 1 |
| West Indies | | | | | | | | | | | 33 | | | 2 | | | | | | 1 | | | | | | | | | | | |
| *SOUTH AMERICA:* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| British Guiana | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| Brazil | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | |
| Peru | | | | | | | | 1 | | | | | 3 | | | | | | | | | | | | | | | | | | |
| U. S. of Colombia | | | | | | | | | | | 2 | | | | | | | | | | | | | 7 | 3 | | | | | | |
| Totals | 209 | 360 | 17 | 10 | 70 | 38 | 70 | 92 | 36 | 15 | 721 | 35 | 85 | 148 | 419 | 34 | 82 | 13 | 145 | 13 | 184 | 45 | 103 | 209 | 137 | 13 | 73 | 17 | 6 | 73 | 375 |

| Classified Objects. | Whetstones. | Polishers—Conical and Oblong. | Pendants, Plummets and Sinkers. | Natural Pebbles and Balls. | Paint Cups. | Limonites. | Mound Relics, Corals, Teeth, etc. Lots. | Beads of Bone. | Beads of Shell. | Beads of Stone. | Beads of Glass. | Arrow Heads. | Spear Heads. | Drills and Reamers. | Scrapers. | Ornaments of Stone. | Ornaments of Bone. | Ornaments of Shell. | Knives. | Flake Knives. | Flakers. | Cores and Nuclei. | Bunts. | Shell Calibashes. | Ornaments of Gold and its Alloys. | Wood Implements and Ornaments. | Bronze Ornaments and Implements. | Quippas and Cloth. | Flutes, Flageolets and Whistles. | Aztec Stamps and Seals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *UNITED STATES:* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| East of Rocky Mountains | | 3 | | 4 | | | | | 1 | | | 42 | 13 | 42 | 19 | 12 | | | 8 | | | | | | | | | | | |
| New England | | | 13 | | | | | | | | | 1 | 5 | | | 3 | | | 5 | | | | | | | | | | | |
| Maine | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Hampshire | | | | | | | | | | | | 101 | 1 | | | | | | 1 | | | | | | | | | | | |
| Vermont | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Massachusetts | | | 17 | | | | | | | | | 144 | 18 | 2 | | | | | 1 | | | | | | | | | | | |
| Rhode Island | | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Connecticut | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | |
| New York | 3 | 3 | 39 | 10 | | | 58 | | 19 | | 3 | 963 | 261 | 29 | 220 | 4 | 1 | 1 | 37 | 56 | | | | | | | | | | |
| New Jersey | | | 1 | | | | | | | | | 19 | 7 | | 1 | | | | 2 | | | | | | | | | | | |
| Pennsylvania | 1 | | 4 | | | | | | | | | 115 | 3 | | 1 | | | | 1 | | | | | | | | | | | |
| Maryland | | | | | | | | | | | | 6 | 1 | | | | | | 3 | | | | | | | | | | | |
| Delaware | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| District of Columbia | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Virginia | | | 1 | | | | | | | | | 367 | 5 | | | | | | 3 | | | | | | | | | | | |
| West Virginia | | 2 | 2 | 11 | 3 | 11 | 152 | 3 | | | | 372 | 41 | 42 | 7 | 10 | 1 | | 18 | | | | | | | | | | | |
| Kentucky | 4 | 3 | 2 | | | | | | 1 | | | 140 | 13 | 2 | 6 | 13 | | | 15 | | | | | | | | | | | |
| Tennessee | | 2 | 6 | 1 | | | | | 53 | | | 126 | 16 | 2 | 17 | 1 | | 7 | 3 | | | | | | | | | | | |
| Ohio | 1 | 21 | 16 | 5 | | 5 | | | 51 | 2 | | 473 | 65 | 34 | 17 | 23 | | | 54 | 7 | | | | | | | | | | |
| Indiana | | 2 | 1 | | | | | | | | | 10 | 3 | 2 | 6 | 4 | 1 | | 10 | | | | | | | | | | | |
| Michigan | | 1 | | | | | | | | | | 24 | 8 | | 3 | | | | | | | | | | | | | | | |
| North Carolina | | 7 | 1 | 3 | | | | | | 4 | 20 | 16 | 1 | 1 | 1 | 8 | | | 1 | | | | | | | | | | | |
| South Carolina | | | 2 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| Georgia | | 6 | 1 | | | | | | | | | 103 | 2 | | | 3 | | 4 | | | | | | | | | | | | |
| Florida | 3 | 3 | 134 | 3 | | | 15 | 2 | 7 | | 2 | 47 | 55 | 3 | 25 | 2 | 1 | 4 | | | | | | 4 | 1 | | | | | |
| Alabama | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mississippi | | | | 2 | | | | | | | | 185 | 29 | 3 | | 1 | | | | | | | | | | | | | | |
| Louisiana | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Texas | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arkansas | | | | | | | | | | | | 47 | 5 | | 71 | | | | | | | | | | | | | | | |
| Missouri | 96 | 84 | 16 | 45 | 4 | 5 | | | 2 | 1 | | 4590 | 1590 | 154 | 636 | 11 | | 2 | 296 | | 19 | 67 | 753 | | | | | | 5 | |
| Illinois | | 1 | | | | | | 4 | 4 | | | 20 | 4 | | 5 | 2 | | 1 | 2 | | | | | | | | | | | |
| Iowa | | | | | | | | | | | | 1 | 2 | | | | | | 3 | | | | | | | | | | | |
| Wisconsin | | | | | | | | | | | | 7 | | | | 1 | | | 1 | | | | | | | | | | | |
| Minnesota | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Kansas | | | 2 | | | | | 9 | | | | | | | | | | | | | | | | | | | | | | |
| Nebraska | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wyoming | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dakota | | | | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| California | | | 2 | | | | | | 1 | | | 10 | | | | 3 | | | 2 | | | | | | | | | | | |
| Oregon | | | 2 | | | | | 12 | | | | 374 | 7 | 9 | 17 | | | | 3 | | | | | | | | | | | |
| Washington | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Montana | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alaska | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 4 | | | | |
| Colorado | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | |
| Utah | | | | | | | | | 1 | 1 | | 64 | 1 | 1 | | | | | | | | | | | | | | | | |
| New Mexico | | | | | | | | | | | | 8 | | | | | | 1 | 1 | | | | | | | | | | | |
| Arizona | | | | | | | | 1 | | 2 | | 12 | | 1 | | 1 | | | | | | | | | | | | | | |
| Idaho | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nevada | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *NORTH AMERICA:* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Canada | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| British Columbia | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mexico | | | | | | | | | | 109 | | 2 | 3 | | 3 | 36 | | 1 | 5 | | | 20 | | | | | 15 | | 4 | 51 |
| Central America | | 1 | | | | | | | | | | | | | | 1 | 1 | | | 2 | | 1 | | | | | | | | |
| West Indies | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *SOUTH AMERICA:* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| British Guiana | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Brazil | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peru | | | | | | | | | | | | 5 | 10 | | 5 | | | | | | | | | | | | | 12 | | |
| U. S. of Colombia | | | | | | | | | | | | | | | | | | | | | | | | | 154 | | 1 | | | |
| Totals | 109 | 141 | 270 | 85 | 7 | 21 | 25 | 30 | 140 | 119 | 25 | 8396 | 2172 | 327 | 1061 | 140 | 6 | 21 | 476 | 65 | 19 | 88 | 753 | 4 | 155 | 4 | 16 | 12 | 9 | 51 |

| Classified Objects. | Copper. Spears. | Copper. Chisels or Celts. | Copper. Knives. | Copper. Hammers. | Copper. Vessels. | Copper. Beads (Lots). | Copper. Bracelets. | Copper. Implements. | Copper. Ornaments. | Copper. Tubes. | Copper. Pipes. | Copper. Arrows. | Copper. Grooved Axes. | Hematite and other Iron Ore. Mineral Lumps. | Paint Lumps. | Balls and Hammers. | Grooved Axes. | Tomahawks. | Club Stones. | Celts & Cutters. | Banner Stones. | Gorgets. | Ornaments. | Grooved Plummets & Sinkers. | Arrow Points. | Irreg. and Lump Burnishers. Rectang. & Oblong Burnishers. Conical, Ellip. & Hemispherical Burnishers. Cylindrical Burnishers. | Pear Shaped Pendants. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *UNITED STATES:* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| East of Rocky Mountains | | 1 | | | | | | | | | | | | 2 | 7 | 2 | 1 | | | 7 | | | | 5 | | 6 | 1 |
| New England | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maine | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Hampshire | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vermont | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Massachusetts | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rhode Island | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Connecticut | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New York | | | | | | | 2 | 1 | 6 | | | 1 | | | | | | | | | | 1 | | | | 1 | |
| New Jersey | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pennsylvania | | 1 | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| Maryland | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Delaware | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| District of Columbia | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Virginia | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 2 | |
| West Virginia | | | | | | | | | | | | | | | 30 | 5 | | | 1 | 113 | | 3 | 3 | 10 | | 41 | 1 |
| Kentucky | | | | | | | | | | | | | | | 1 | | | | | 4 | | 2 | | 3 | | 8 | 1 |
| Tennessee | | | | | | | | | 7 | | | | | | 1 | | | | 1 | 1 | | | | | | 3 | 1 |
| Ohio | 1 | 1 | | 1 | | 23 | 1 | 1 | 6 | 1 | 1 | | | 3 | 14 | 5 | | | 4 | 177 | | 5 | 2 | 22 | 3 | 65 | 11 |
| Indiana | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| Michigan | 3 | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| North Carolina | | | | | | | | | | | | | | | | | | | 4 | | | | | | | 3 | |
| South Carolina | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Georgia | | | | | | | | | | | | | | | | | | | 9 | | | | | | | | |
| Florida | | | | | | 1 | | | 2 | | | | | | | | | | | | | | | | | | |
| Alabama | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mississippi | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Louisiana | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Texas | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arkansas | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missouri | | | | | | | | | | | | | | 1 | 154 | 1 | 19 | 4 | 2 | 187 | 1 | 8 | 8 | 25 | 1 | 40 | 13 |
| Illinois | 4 | 3 | 1 | | | | | | | | | | | | | | 3 | | | 7 | | | | | | 8 | 14 |
| Iowa | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| Wisconsin | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Minnesota | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Kansas | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nebraska | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wyoming | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dakota | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| California | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Oregon | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Washington | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Montana | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alaska | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colorado | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Utah | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Mexico | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arizona | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Idaho | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nevada | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *NORTH AMERICA:* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Canada | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| British Columbia | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | |
| Mexico | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | |
| Central America | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| West Indies | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *SOUTH AMERICA:* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| British Guiana | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Brazil | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peru | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| U. S. of Colombia | | 1 | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| Totals | 9 | 7 | 2 | 1 | 1 | 24 | 5 | 2 | 21 | 1 | 1 | 1 | 3 | 6 | 207 | 13 | 24 | 4 | 21 | 500 | 1 | 20 | 13 | 65 | 4 | 177 | 42 |

Copper Objects, 78.

Objects in Hematite and Iron Ore, 1097.

# Article XI.—THE TEMPLE OF TEPOZTLAN, MEXICO.

By M. H. Saville.

Plates V-IX.

## Introduction.

This old temple, called by the Indians "La casa del Tepozteco," has remained unknown to others until a few months ago.[1] The existence of tombs in this region is indicated in the archæological map of the Republic of Mexico, published by Leopold Batres in 1886, but no data is to be found bearing upon this temple.

It is due to the enthusiasm of Mr. Francisco Rodriguez, a young civil engineer, and a native of Tepoztlan, that we are now able to give a description of this most interesting structure. During the months of August and September of the past year, Mr. Rodriguez was engaged in the excavation of the temple with a large force of Indians who voluntarily gave their services, and to-day take great pride in the result of their labor.

Mr. Rodriguez read an account of his explorations before the Congreso de Americanistas, held in Mexico during the month of October, last autumn.[2] A résumé was published in a small paper recently started in the town of Tepoztlan, under the title 'El Grano de Arena,' in the first number, which appeared Feb. 15, 1896. This paper publishes with each number several columns of matter in the Nahuatl language.

The town of Tepoztlan is situated in the State of Morelos, about twelve miles northeast of Cuernavaca, the capital of the State. It is at the extreme northeastern limit of the extensive Valley of Cuernavaca, at the southwestern border of which are situated the famous ruins of Xochicalco. It may be easily reached from the City of Mexico by two routes; the first being by the Mexican, Cuernavaca and Pacific Railroad, which now terminates at Tres Marias, but will in the near future be extended to Cuernavaca. At the present time a lumbering stage-coach is used

---

[1] This paper was read before Section H of the A. A. A. S. at the Buffalo meeting, August, 1896.

[2] This account will appear in the Report of the Congress, now being printed by the Department of Justice and Public Instruction, of Mexico.

to traverse the distance. At Cuernavaca it is necessary to take mules for a rough ride of about twelve miles to Tepoztlan.

The other route is by the Interoceanic Railroad to Yautepec, a most picturesque ride, passing in close proximity to the base of Popocatepetl, and winding through the fertile valley of Cuautla. From Yautepec mules are taken for an ascending ride of ten or twelve miles to Tepoztlan.

By the first route the journey is through the Cuernavaca Valley; by the second, through the Cuautla Valley. Tepoztlan being located on elevated ground between rugged cliffs which divide the two valleys, commands a view of both, a most strategic site for a town, and easily defended from invaders.

This locality is in the nature of a plain inclining from west to east, protected at the north and south by bold and rugged mountains. The cliffs rising to the south of the town are less imposing and much easier to climb.

It was among the sheltered spots here that the ancients built their tombs, several of which have been found, being in the form of stone-lined cysts. The most prominent peak of this southern range is at the western end, towering high above the rest, guarding, as it were, the Cuernavaca Valley. This mountain is named Chalchihuitepetl, or hill of the Chalchihuite, the sacred green stone of ancient Mexico and Central America. There are said to be old quarries on the southern side of the mountain which have not yet been investigated.

The imposing cliffs which rise to the north of the town present the aspect of buttes, from the recesses of which break forth springs of water which unite in one stream and flow through the town, affording a never-failing source of water to the inhabitants.

It is a most picturesque spot, and formerly must have supported a large population, many aboriginal relics abounding, some of which have been gathered together and placed in a building set apart by the municipality for a museum.

The people living here are lineal descendants of the Aztecs; at no place in Mexico is the sonorous Nahuatl language spoken with greater purity, or old customs adhered to with greater tenacity, the people taking great pride in their ancestry.

The population is between five and six thousand, and although there are eight churches, only one priest presides over them all. During feast days the sounds of the old wooden drum, the Teponaztli, and the clay flute, the Chirimia, are still heard.

We have here the interesting spectacle of a town of almost pure aboriginal blood, almost unknown in the City of Mexico, and within a day's journey of the same, possessing a museum for the preservation of the antiquities of their ancestors, and publishing a paper in both Spanish and Nahuatl.

I visited the place last April in company with Mr. Rodriguez, whose services were of the greatest value, and through his assistance in securing Indians to carry my photographic instrument and refreshments, I was able to spend an entire day at the ruin. I secured photographs of the temple, but the air was so filled with smoke from burning brush, that it was impossible to take good general views of the landscape.

## Description of the Temple.

On one of the most inaccessible peaks of the northern range of mountains, at a point which commands a view of the whole region, was erected the old temple. It can be barely discerned from the town, and the ascent to the summit of the peak is arduous, and in some places, dangerous.

After leaving the town, the ascent is constantly upward until the base of the cliffs is reached, upon which, nearly two thousand feet above, is the temple. We enter a long cañon, and begin the difficult part of the ascent. Climbing upward we often encounter long flights of steps, some merely cut out of the solid rock, while others are stones placed to form steps. The appearances indicate that there was once a continuous flight, but many of the steps have been washed away by the torrents of water which flow through here during the rainy season. On the vertical walls which rise on either side are several inscriptions carved in the rock.

About half the distance up the mountain we wind around the cliff and begin the most difficult part of the ascent. In some places for nearly one hundred feet the ascent is nearly vertical, steps

being cut in the rock and in other places masonry being built to support the steps.

When Mr. Rodriguez began his explorations he found it necessary to place ladders in two places, as the cañon is blocked by fallen boulders.

The last three or four hundred feet are really dangerous; a false step would precipitate one to certain death. A few men at these points could successfully resist the invasion of hundreds.

Reaching the summit we find an irregular surface divided in two parts, connected by a narrow neck; upon the western one is the temple. The eastern part contains the vestiges of low walls and terraces, occupying nearly the entire area. These may be the remains of the houses of the priests, the guardians of the sacred spot. To the back rises a cliff clothed with pine trees; this cliff can only be reached from this place. Mr. Rodriguez found water here. Until last fall the temple was simply a mound in which terraces might be discerned. It rises above the base upon which the foundations were placed to the height of twenty meters, and nearly covers the entire surface of the point, which slopes sharply from the centre to the eastern end. This point is about thirty meters in length, from east to west, and nineteen meters in width.

The eastern end of the temple shows a structure composed of four parts; the lowest is simply a rude foundation built against the sloping surface of the peak. It is built of rough stones cemented together, and may have been covered with cement, but it has now entirely disappeared. This serves as a foundation for the second part, which is the foundation proper; it is in the form of a truncated pyramid, the sides rising at a vertical slant of fifteen degrees. The western surface of the peak was leveled in its construction, and the remains of its western and northern edges form a fort-like structure, which rises about two meters above the base of the pyramid.

Against the eastern side of the pyramid are the remains of a steep flight of steps which led to the top. Near the southern side, a little removed from the base, are the low walls of several chambers rising to the height of 1 meter 25 centimeters. Resting upon the lower pyramid is a smaller one of the same form, the base of which is reached by a steep flight of steps built against the western end of the lower structure.

Ascending these steps we reach the level platform and are in front of the old temple, which faced the west. In the centre of this platform are the remains of a small, square platform with serrated corners, which was once used as the sacrificial altar. The smaller pyramid served as the foundation for the building, which is reached by a steep flight of steps, twelve in number; the upper half was destroyed by the fall of the front wall of the building.

The temple is slightly smaller than the pyramid, leaving a narrow ledge on the four sides, just wide enough to walk upon. The outer walls are 1 meter 90 centimeters in thickness, composed of rubble stone strongly cemented together, and rising to the height of 2 meters 50 centimeters. Nothing remains of the front wall, with the exception of two low, square columns, showing a wide central doorway with a narrow one on either side. The temple is divided into two rooms, the outer one being 6 meters long, from north to south, and 3 meters 73 centimeters wide, from east to west. The roof had fallen in, filling the rooms with débris, but the excavations of Mr. Rodriguez revealed an almost level arch.

At either end of the front room was a narrow bench or seat, built against the wall. In the centre of the chamber Mr. Rodriguez found the remains of a raised rectangular platform, probably the place where the sacred fire was lighted, as fragments of copal and charcoal were found in the débris.

The pilasters forming the sides of the doorway leading to the inner chamber are covered with stucco, and are highly ornamented; the lower portions are decorated with a fluting, above which is seen the familiar fret found at Mitla. Above this is what appears to have been the representation of the sun symbol, the lower part only being preserved.

The doorway is 1 meter 90 centimeters wide, and the inner wall is 90 centimeters in thickness. The inner chamber is 6 meters long and 5 meters 20 centimeters wide. Running around three sides of the room is a bench faced with carved stones; this bench is 64 centimeters high and 42 centimeters wide. The upper part projects, forming a slight coping; the top was covered with cement. The coping is inscribed with chronological signs, while the lower part has four ideographs at each end. The exact number on the side of the room cannot be determined, as the bench

here is somewhat destroyed. In the centre of the bench, at the back wall, Mr. Rodriguez found the remains of an altar, and two carved fragments, one painted red, the other in the shape of a crown; there, probably, was placed the idol.

The carving in this room was finely executed, and traces of the red paint, which once covered them, can still be seen. The walls were covered with a smooth cement, showing traces of red, blue, black and yellow paint. The whole structure was carefully erected, the lines of the pyramid being accurately proportioned. The work of transporting the material used must have been enormous. In the explorations potsherds, stone implements, and several small stone death's heads were found.

The most important feature of this ruin is the hieroglyphic inscription which was found in the southern side of the lower pyramid; here were discovered two stone tablets about two feet in diameter; these were removed and are now in the town. The first tablet contains the hieroglyphic representation of the mythical animal Ahuizotl or water rat; it was the sign of the Emperor Ahuizotl, the seventh Aztecan monarch, who ruled, according to Mexican chronology, from 1486 to 1502, preceding Montezuma. He was a man of energy and a bloodthirsty ruler. He extended the limits of the empire, completed the temple of Mexico, and erected many buildings. On the second slab is carved a rabbit and ten dots; this is the chronological sign, 10 Tochtli, which corresponds to 1502 of our era. This would seem to establish the date of the erection of the temple in 1502 by Ahuizotl, 17 years before the entry of Cortez into Mexico. The importance of the old temple of Tepoztlan cannot be overestimated, it being the only aboriginal structure still standing in Mexico to which we can probably assign a positive date. As it stands to-day it bears every evidence of antiquity, and one would be inclined to assign it a much greater age.

It is to be hoped that excavations may be continued at this place, which may still further bring to light material of great importance for the student of Aztecan remains.

NOTE.—I am under great obligations to Mr. Rodriguez, who has kindly furnished me with a copy of his plan of the Tepoztlan Temple, herewith reproduced.

## EXPLANATION OF PLATES.

---

PLATE V.—General view of Temple, looking southwest across the narrow cañon through which the ascent is made.

PLATE VI.—View of the Temple, looking northwest.

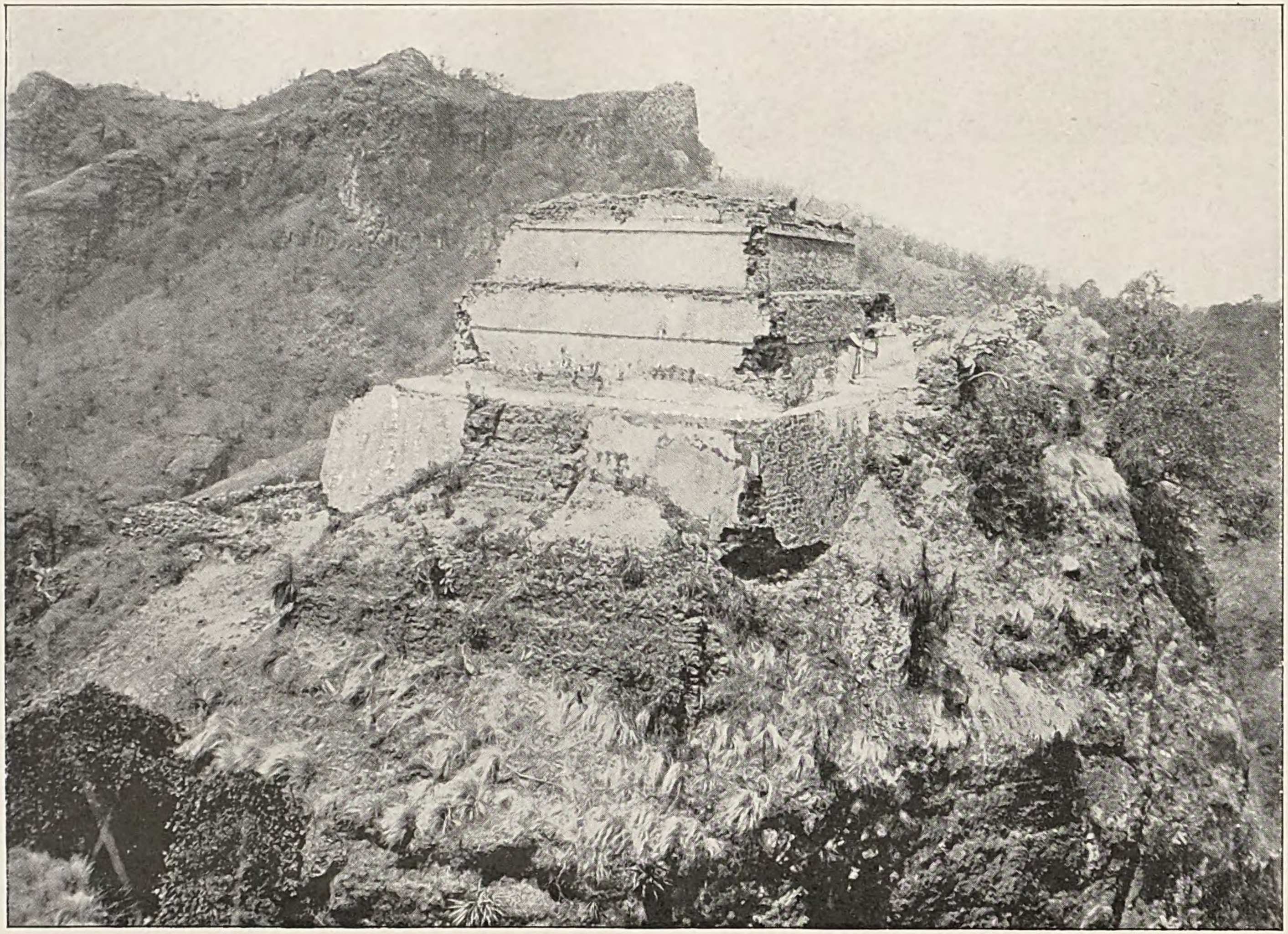
PLATE VII.—Front of Temple, looking west.

PLATE VIII.—Northern end of inner chamber, showing bench with sculptured front.

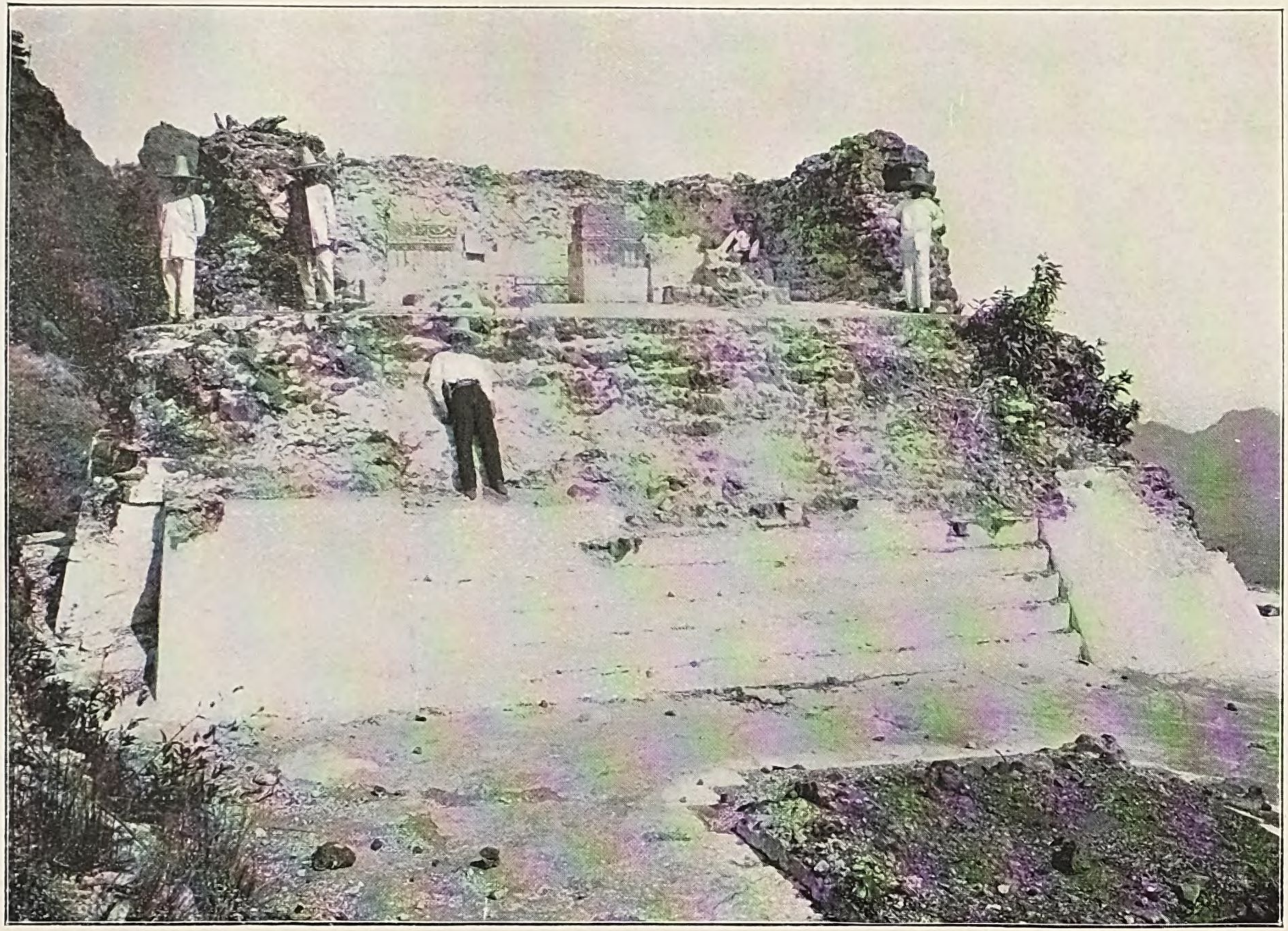
PLATE IX.—Ground Plan of Temple.



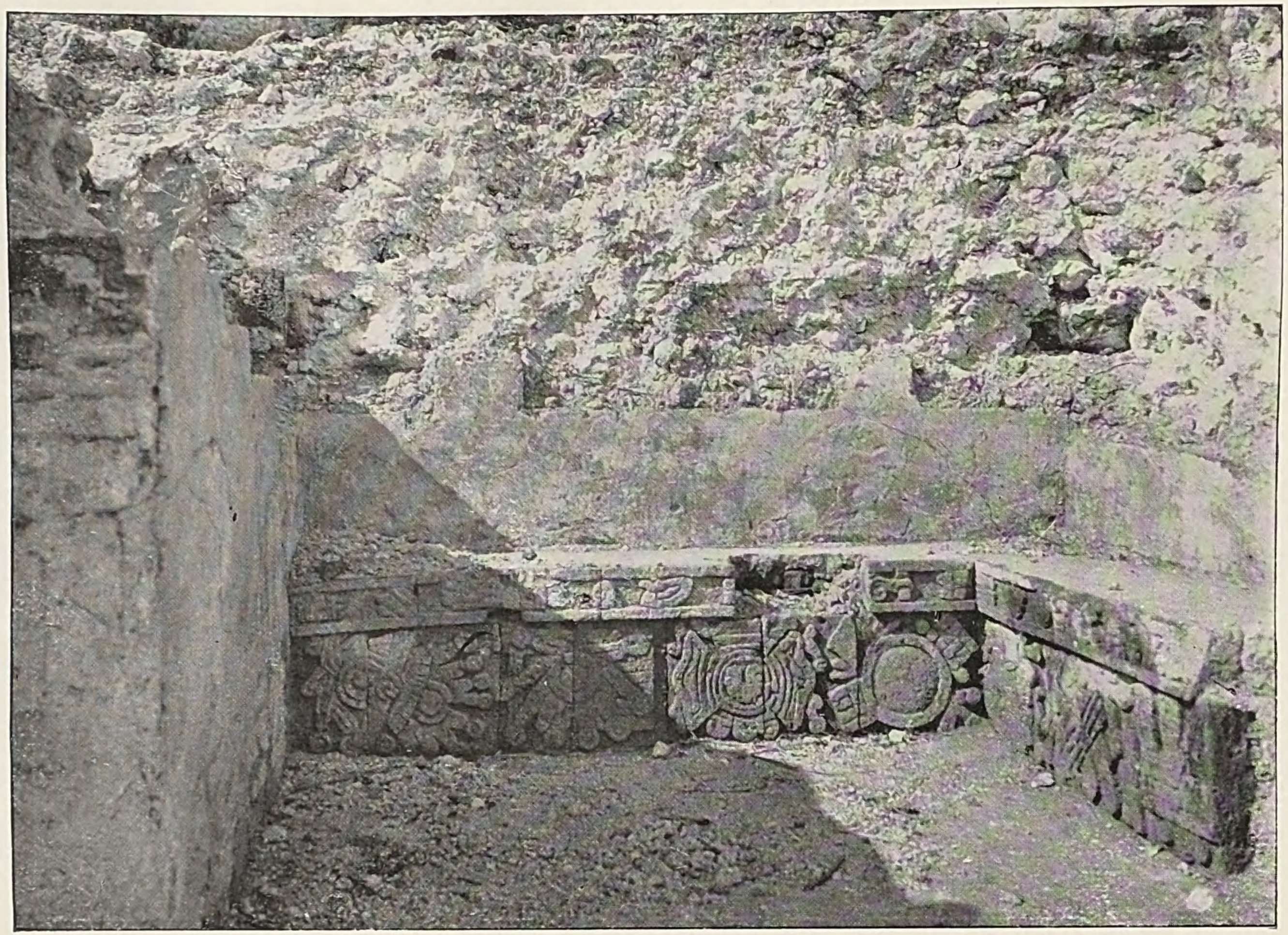
VIEW OF TEMPLE, LOOKING SOUTHWEST.



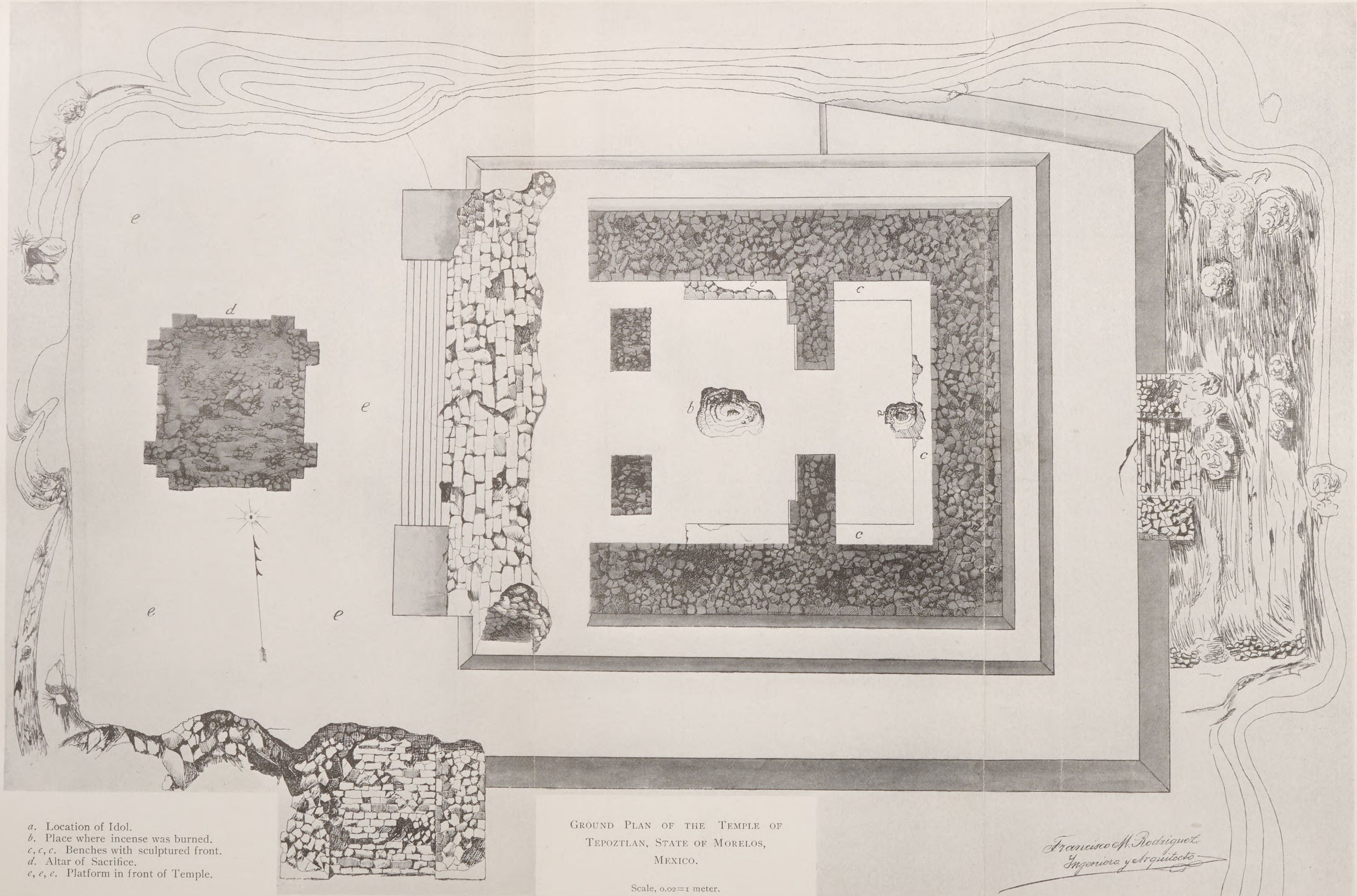
View of Temple, Looking Northwest.



Front of Temple, Looking West.



NORTHERN END OF INNER CHAMBER OF TEMPLE.




*a*. Location of Idol.
*b*. Place where incense was burned.
*c*, *c*, *c*. Benches with sculptured front.
*d*. Altar of Sacrifice.
*e*, *e*, *e*. Platform in front of Temple.

Ground Plan of the Temple of Tepoztlan, State of Morelos, Mexico.

Scale, 0.02=1 meter.

Francisco M. Rodriguez
Ingeniero y Arquitecto

# Article XII.—A ROCK PAINTING OF THE THOMPSON RIVER INDIANS, BRITISH COLUMBIA.

By James Teit.

Edited, from notes of the collector, by Franz Boas.

In the interior of British Columbia numerous rock paintings are found, most of which are laid on in red ochre. Many of these have the appearance of having been made quite recently. Mr. James Teit has had the good fortune to find one near Spence's Bridge, B. C., which the Indians were able to explain in detail.

According to the custom of the Thompson River Indians, who form a branch of the Salishan family, girls on reaching maturity must retire to the hills where they undergo a long ceremony of purification and make offerings to secure good luck. At the end of this period they record their offerings and the ceremonies that they have performed on a boulder. The subjects of these records are therefore identical in many cases, and all the women of the tribe are able to interpret their meaning. Mr. Teit found a boulder of this sort near Skaitôk,[1] about one mile northeast of Spence's Bridge. It is partly imbedded in the ground and faces northward and southward. The paintings are all on the south side. The size of the boulder is about six feet square, and it rises to a height of four feet above the ground. The paintings occupy a space about 5½ feet by 4 feet in size.

The explanations were given by Waxtko,[2] an old woman living at Spence's Bridge. In giving her explanations she stated that she had made paintings of the same character when undergoing the ceremonial of purification at the time when she reached maturity, and that she was perfectly familiar with the meanings of all the designs. According to her statement the paintings were made by various girls at the time when they reached maturity. This is borne out by the appearance of the paintings, some of which are quite fresh, while others appear old and indistinct.

---

[1] *ô*=*o* in German *voll*.
[2] *x* aspirate guttural, like *ch* in Scotch *loch*.

In order to facilitate description I have numbered the paintings, and where it seemed desirable, separated the individual figures by broken lines.

FIG. 1.—The crossing of two trails. At such places girls used to bury part of the food they were given after having fasted four days at the beginning of the period of purification.

FIG. 2.—Crossing of trails ; see Fig. 1.

FIG. 3.—Four fir branches, such as the girl had to deposit at the entrance of her lodge, which was built of three or four fir branches. The horizontal line connecting the three branches at the left hand side indicates that they were placed near each other.

FIG. 4.—A fir branch, the needles of which have been plucked off ; used as an offering. The girls pluck the needles one by one, that their fingers may become nimble, and that they may not grow tired by the work that will be her share in life.

FIG. 5.—A girl's lodge, made of fir branches. The lower portion of the figure up to the dotted line represents fir branches that hang down from the roof of the lodge. The girl plucks the needles from these one by one. The top of the figure represents the roof of the lodge, or the fir branches placed in front of the entrance, like Fig. 3.

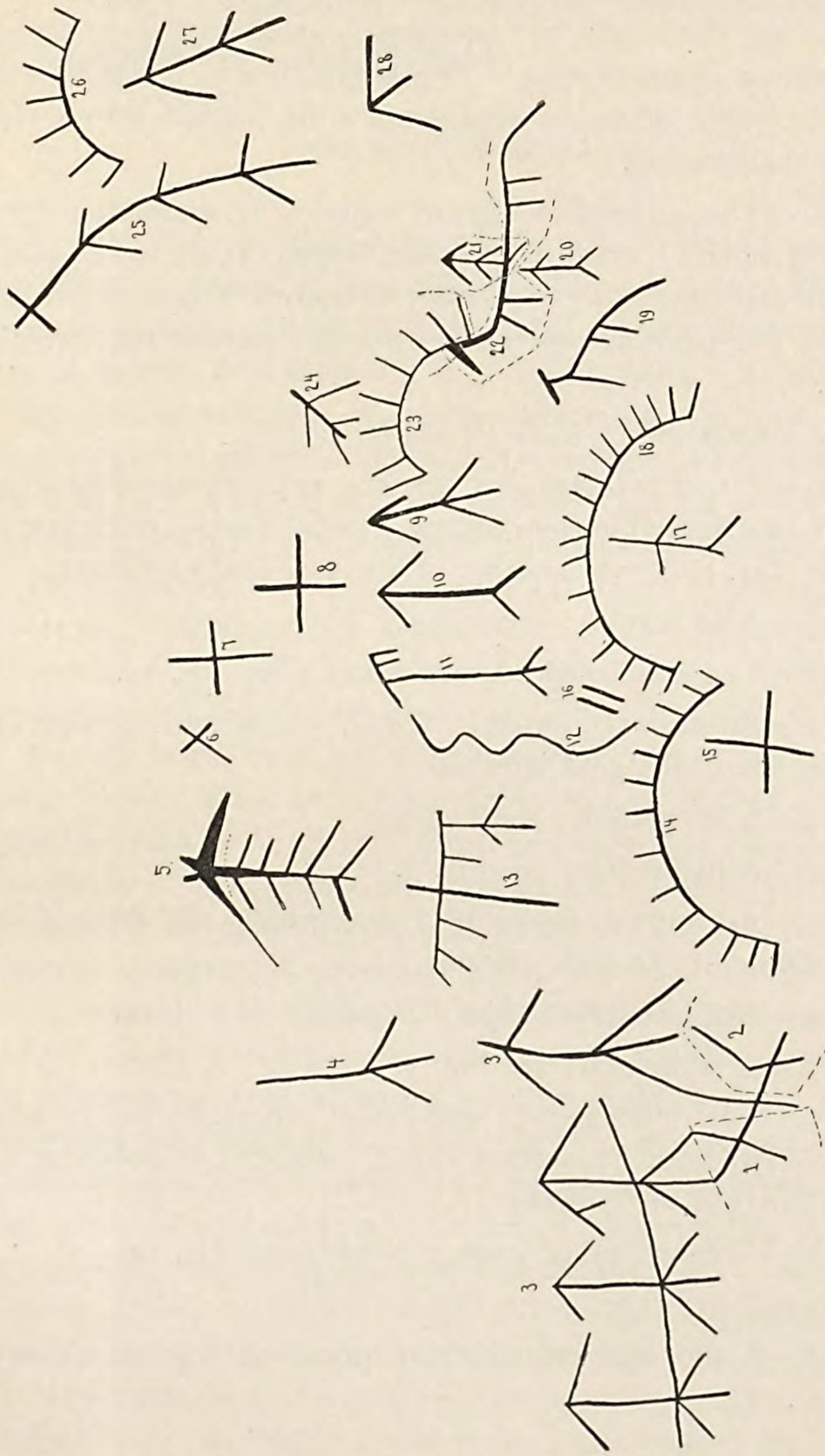
FIGS. 6, 7, 8.—Crossing of trails ; see Fig. 1.

FIG. 9.—A fir branch ; see Fig. 3.

FIG. 10.—The explainer was in doubt if this figure was a poor representation of a fir branch—it will be noticed that the short central line at the base is missing—or if it meant a trench with a fir branch at each end. Girls used to dig trenches in order to attain skill and endurance in digging roots and doing hard work of all kinds.

FIG. 11.—The cross line on top of this figure and the two downward lines to the right represent the roof of a fir lodge. The long line with the short diverging lines at its lower end represent a fir branch which is suspended from the roof of the lodge, the needles of which have been plucked off ; see Fig. 5.

FIG. 12.—A snake, which had probably formed the subject of one of the girl's dreams.



ROCK PAINTING, THOMPSON RIVER INDIANS, B. C.

FIG. 13.—The two long lines which cross at right angles represent the crossing of trails. The four short lines which run downward from the horizontal line represent four sticks that are placed at the crossing as an offering. The longer line to the right with its two diverging branches represents a fir branch that is also placed at the crossing.

FIG. 14.—The unfinished edge of a mat or of some other kind of basketry work. Girls had to make, during the period of isolation, small mats and baskets in order to become expert in this line of work. The painting represents work of this kind that the girl has done.

FIG. 15.—Crossing of trails; see Fig. 1.

FIG. 16.—Either two trenches (see Fig. 10), or two sticks given as an offering, or simply the numeral two (2) having reference to the snake (Fig. 12), or to another of the surrounding figures.

FIG. 17.—A fir branch; see Fig. 3.

FIG. 18.—The unfinished edge of a mat; see Fig. 14.

FIG. 19.—An animal, probably a dog, which had formed the subject of one of the girls' dreams.

FIG. 20.—A fir branch; see Fig. 3.

FIG. 21.—A fir branch; see Fig. 3.

FIG. 22.—An animal, probably a dog, which had formed the subject of one of the girls' dreams.

FIG. 23.—The unfinished edge of a mat; see Fig. 14.

FIG. 24.—A fir branch; see Fig. 3.

FIG. 25.—The upper part of this figure represents the crossing of trails. The branches farther down represent fir branches set up as offerings at the crossing.

FIG. 26.—The unfinished edge of a mat; see Fig. 14.

FIG. 27.—A fir branch; see Fig. 3.

FIG. 28.—Either a fir branch or an imperfect representation of a fir lodge.

## Article XIII.—DESCRIPTION OF A NEW GENUS OF FOSSIL BRACHIOPOD FROM THE LOWER HELDERBERG LIMESTONES.

By R. P. Whitfield.

In Vol. III, Palæontology N. Y., p. 224, Prof. James Hall describes a species of Brachiopod under the name *Rhynchonella æquivalvis*, and figures it on Plate xxix. Under the description of the figures, in a footnote, he says, "This species is probably not a true Rhynchonella, its surface characters and form approach Rensselæria, while in other respects it resembles Rhynchospira." In Vol. VIII, Part II, of the same work (Introd. to the Study of the Genera of Pal. Brachiopoda), it is not mentioned.

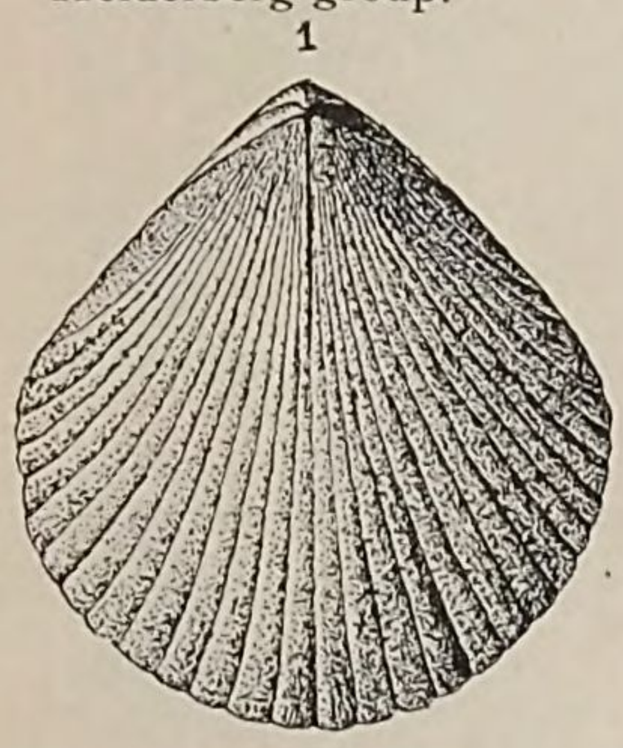
In examining the specimens for cataloguing the types in the Museum collections, we find that it differs in some essential characters from any known genus of Brachiopods, and consequently are compelled to establish a new genus for its reception.

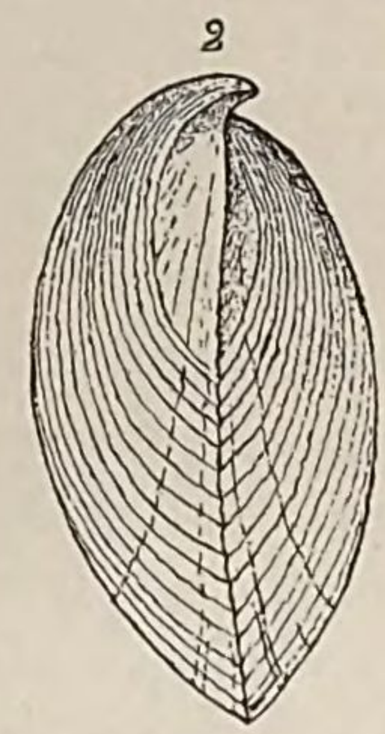
The shells are small, generally less than three-fourths of an inch long, broadly ovate in outline, nearly equally convex on the two sides, sometimes quite thin dorso-ventrally, but frequently quite ventricose; beaks small, not perforated; surface plicated with moderately strong radiating ribs which are convex, smooth, and entirely destitute of interspaces, the edges of the ribs being in close contact. This is a peculiar feature, and gives basis for the generic name Lissopleura, by which I propose to designate it. In external features the shells much resemble a *Rhynchospira*, as remarked by Professor Hall, but there is no perforation in the beak as in that genus, neither is the beak so prominent, but small and more closely incurved. It differs also in being destitute of interspaces between the plications of the exterior. From *Rensselæria* it differs internally in the possession of a strong median septum in the dorsal valve, while in the ventral it presents almost the same features as those of that genus, namely, a narrow trough-shaped or spoon-shaped cavity in the beak, formed by the dental plates, and a rather deep but narrow muscular scar below. As yet I have not been able to ascertain what form of appendages

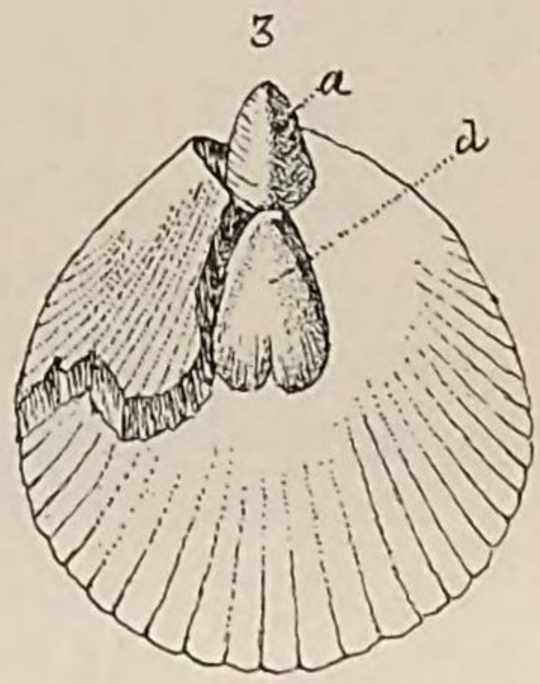
exist in the interior, as most of the specimens in the collection are filled with opaque matter, and do not show any feature on cutting, consequently we must depend on the external features already mentioned for generic identification for the present. I think, however, that it is more than probable that it will ultimately be found to belong to the Terebratulidæ.

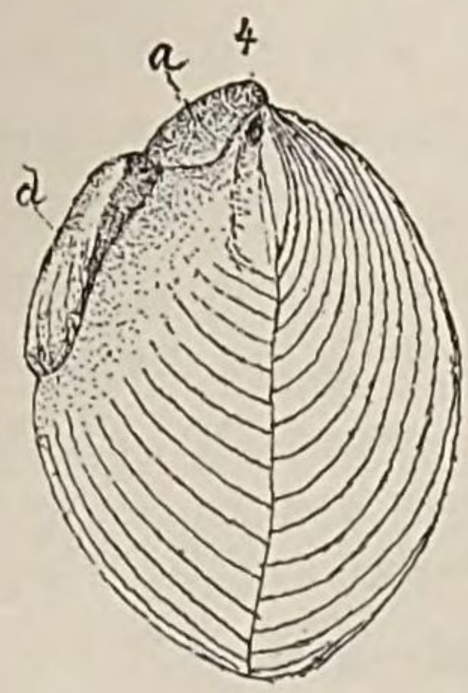
## **Lissopleura,**[1] new genus.

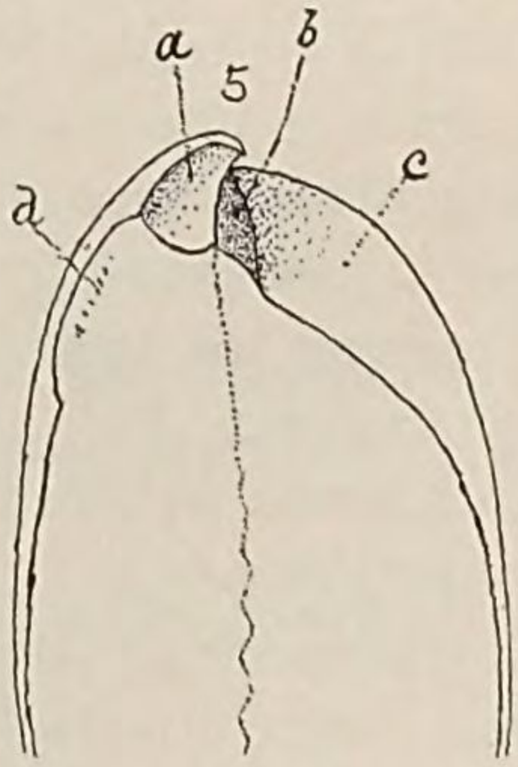
A Brachiopodous shell, more or less inequivalve, with a small imperforate beak ; surface radiately ribbed ; ribs smooth, without interspaces ; shell substance fibrous. Ventral valve with a spoon-shaped cavity in the beak, formed by the dental plates, and a deep bilobed muscular imprint in front of it. Dorsal valve with a strong median septum. Type, *Rhynchonella æquivalvis* Hall. Lower Helderberg group.




### Description of Figures.

Fig. 1, Dorsal view of one of the types, showing the general form. Fig. 2, Outline profile of same. Fig. 3, Ventral side of a specimen from which the shell has been partly removed ; *a*, the filling between the dental plates ; *d*, the muscular scar. Fig. 4, Profile of the same specimen in outline. Fig. 5, View, in outline, of a specimen broken through the center so as to show the thickness of the shell, dental plates (*a*), and septum of the dorsal valve (*c*), the projecting lamellæ of the dorsal valve (*b*), and the thinning of the shell at the muscular scar (*d*) of the ventral valve. All the figures are enlarged two diameters.

[1] λισσός, smooth ; πλευρά, rib.

# Article XIV.—DESCRIPTIONS OF NEW NORTH AMERICAN MAMMALS.

By J. A. Allen.

## *Rangifer terrænovæ*, sp. nov.

Plates X and XI.

*Rangifer tarandus terrænovæ* Allen, on labels attached, in May, 1896, to mounted specimens on exhibition in the American Museum of Natural History.

During the last few years the Museum has accumulated a considerable series of Caribou, from Maine, New Brunswick, Newfoundland and Greenland, numbering altogether about twenty-five specimens. A comparison of these shows that the form occurring in Newfoundland is very distinct from that of the mainland, commonly known as *Rangifer tarandus caribou* (Gmelin), and also from the Greenland form, *Rangifer tarandus grœnlandicus* (Gmelin). It may be characterized as follows:

*Adult Male, Autumn Pelage.*—Body above grayish brown, becoming lighter on the flanks, and passing into nearly pure white on the ventral surface; neck all round soiled white, rather purer white in front; a broad, not sharply defined eye-ring, and the whole nose and lower portion of face, including terminal portion of lower jaw, grayish white; rest of the head like the back; edges and lower surface of tail and buttocks white; front and outer surface of limbs brownish gray; feet and apical third of carpal and tarsal segments white, passing gradually into the general color of the limbs.

*Adult Female.*—Similar to the male in general coloration, but with rather less white.

*Young of the Year.*—Darker even than the adult female, with a prominent dusky lateral line and a blackish dorsal band, broadening over the shoulders.

*Type*, No. 11775, male ad. (mounted), Grand Lake, Newfoundland, Nov. 4, 1895; Dr. C. B. Parker.

In this form the size is large, and the antlers are especially massive, with numerous points, as shown in the accompanying illustrations (Plates X and XI).

In New Brunswick specimens, strictly comparable as to season, the body and limbs are much darker, the dark portion extending below over the anterior half of the ventral surface. The muzzle is dark, like the face, except the front of the upper lip. The white on the distal portion of the limbs is confined to a sharply-defined narrow band, about half an inch in width, bordering the hoofs, rising behind to enclose the accessory hoofs. The white eye-ring is absent. The antlers are thick and heavy for their length.

In the Greenland form there is a broad, sharply-defined white eye-ring, the front of the muzzle is white, and the hoofs are bordered by a broad, sharply-defined white line. In this form the antlers are slender, very variable in size and form, and with few points.

In three specimens of the Lapland Reindeer the white bordering the hoofs spreads indefinitely upward without sharp definition, and the upper surface of the tail is but little darker than the edges and lower surface. The antlers are large and heavy. This form has the appearance in other respects of being a quite different animal.

From the geographical isolation of the Greenland and Newfoundland forms, coupled with well-marked differences in color and other features, they may perhaps better take the rank of species than of subspecies.

I have at hand no examples of the Barren-Ground Caribou, but writers of authority, notably Baird and Caton, have contended for its specific distinctness from the Woodland Caribou, as well as the specific distinctness of both from the Reindeer of the Old World. If this view be correct, as seems to me probable, the American forms of *Rangifer* will stand as follows:

*Rangifer caribou* (Gmelin). Woodland Caribou.
*Rangifer terrænovæ* Allen. Newfoundland Caribou.
*Rangifer grænlandicus* (Gmelin). Greenland Caribou.
*Rangifer arcticus* (Rich). Barren-Ground Caribou.

*R. terrænovæ* is based on a series of 6 specimens, collected at Grand Lake, Newfoundland, the first week in November, 1895, by Dr. C. B. Parker. Three of the specimens, an adult male, an

adult female and young male of the year, presented by Dr. Parker, are mounted in the collection of North American Mammals, and for the last six months have been exhibited in the Museum under the name "*Rangifer tarandus terræ-novæ* Allen."[1]

## Reithrodontomys laceyi, sp. nov.

### Lacey's Harvest Mouse.

*Reithrodontomys mexicanus intermedius* Allen, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 136 (in part) ; *ibid.* VIII, 1896, p. 66.

Above yellowish brown, strongly mixed with blackish, the black-tipped hairs increasing in abundance toward the median line, without, however, forming a distinct dorsal area ; generally an indistinct fulvous lateral line, varying in distinctness according to the season. Below grayish white, the fur plumbeous at base and tipped broadly with whitish. Feet dull soiled white ; ears large, thinly haired, brown externally, yellowish brown internally. Tail long, distinctly bicolor, the upper third dull brown, the rest soiled grayish white, covered with fine short hairs, which form a slight pencil at the tip.

*Type*, No. $\frac{12212}{10564}$, ♀ ad., Watson's Ranch, 15 miles south of San Antonio, Texas, March 6, 1896 ; H. P. Attwater.

The young adults are darker, with less fulvous.

In the new full coat the fulvous tint is stronger, the lateral line broader and brighter, and the lower surface whiter. In worn breeding pelage the tints are all paler.

*Measurements.*—Type specimen, ♂ ad. : total length, 156 ; tail vertebræ, 89 ; hind foot, 19 ; ear (from skin), 12.

Eleven adults range as follows :

| | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 6 ♂♂..... | 158 (142–165) | 90 (84–100) | 19 (18–19.5) |
| 5 ♀♀ ..... | 152 (140–156) | 85 (79– 89) | 18.5 (16?–19) |

This species is based on a series of 13 specimens, all practically adult, taken as follows : San Antonio, Texas, 4 males and 3 females, Feb. 28, March 19, May 12, 15 and 30, and Aug. 21, H. P. Attwater ; Turtle Creek, Kerr Co., Texas, 2 males and 4 females, Jan. 16, 17 and 28, Feb. 5 and 21, and May 30, Howard Lacey. Two of these specimens (one immature, the other in bad condition, and both without measurements) were formerly referred

[1] Since this paper was put in type, Mr. O. Bangs has described this form under the name *Rangifer terræ-novæ*, in a leaflet inscribed as follows : "Actual date of distribution, Wednesday, Nov. 11, 1896, at 5 o'clock P. M." !

(l. c.) to *R. mexicanus intermedius*. The present fine series shows the impropriety of such a reference, *R. laceyi* being much smaller than either *R. m. intermedius* or *R. m. aurantius*. In coloration it resembles neither very closely.

The species is named for Mr. Howard Lacey, of Kerrville, Kerr Co., Texas, who has materially assisted Mr. Attwater in his mammalogical work.[1]

Mr. Attwater has kindly furnished the following field notes.

"These Harvest Mice are found in all parts of this (Bexar) county, except the river lowlands, where I have not yet seen them. I have seen them in the same field with *Reithrodontomys dychei*. They are generally found in the chaparral and brush regions, and in cultivated fields and orchards on the ranches. They make their nests in old woodpecker holes in fence-posts, and also in old birds' nests, such as Orchard Orioles, Verdin, etc. An Orchard Oriole's nest is sent with the nest of one of these Harvest Mice inside of it. It was taken from a peach tree in Mr. Watson's orchard on the Medina River, fifteen miles southwest of San Antonio. The mouse was seen to escape from the oriole's nest, so there can be no doubt about the species. They also construct nests of their own, a small round ball of grasses, etc., which is placed in a low thorn bush, or on the lower limb of a mesquit or huisatch tree, but more frequently among the broad leaves of the Opuntia, where they are well protected by thorns. You have some of these nests, which I sent in a previous lot. One belonged to a male, and was taken Aug. 21, 1895; the other to a female, with three young, taken Aug. 23, 1896. I have found only one full-grown mouse in each nest. Mr. Lacey has found mice-nests on cornstalks, made from corn silk, which he thinks were made by this species.

"These mice seem to be fond of peaches, eating the peach and leaving the stone hanging on the tree. Samples of the peach stones are sent which were found on the peach tree from which the oriole's nest was taken; they were on the same limb, within a few inches of the nest. They also eat weed seeds and grain, and have been caught in traps baited with oatmeal. They are not very numerous, being only occasionally met with."

[1] See this Bulletin, VIII, 1896, p. 49, and pp. 51-80, *passim*.

## Perognathus mearnsi, sp. nov.

*Perognathus flavus* ALLEN, Bull. Am. Mus. Nat. Hist. VIII, 1896, p. 58 (not of Baird).

Above intense ochraceous, conspicuously varied with black over the greater part of the dorsal area, the black diminishing on the sides, leaving a broad lateral line nearly pure ochraceous; broad ochraceous eye-ring; whole lower parts white; spot behind the ear buff; ears dusky; tail light grayish brown, a little darker above than below.

*Suckling Young.*—Grayish brown varied with black; ear-spot light buff; eye-ring bright buff; a narrow bright ochraceous lateral line; below pure white; tail darker than in adults.

Two-thirds grown young are similar, but lighter and more grayish above.

*Measurements.—Male* (type). Total length, 109; tail vertebræ, 52; hind foot, 14; ear (from skin), 4.5.

A series of 9 adult males and 7 adult females measures as follows: *Males.* Total length, 104.5 (100–109); tail vertebræ, 49.5 (45–53); hind foot, 13.7 (13–14). *Females.* Total length, 101 (95–109); tail vertebræ, 47 (41–53); hind foot, 13.8 (13–15). The ear in the dried skin ranges from 4 to 5 mm.

*Skull*, greatest length, 18.5; greatest breadth, 11.

*Type*, No. $\frac{11957}{10395}$, ♂ ad., Watson's Ranch, 15 miles southwest of San Antonio, Texas; H. P. Attwater.

This form differs from true *P. flavus* in much brighter coloration, being much the most intensely colored of the *P. flavus* group, with smaller and darker ears. The mastoid area of the skull is much less expanded, and the interparietal is larger and more quadrate.

Represented by 11 adult males, 9 adult females, and 5 young of various ages. Nearly all were taken at Watson's Ranch by Mr. Attwater, at the following dates: Jan. 28, Feb. 25, March 1, 6, 7, 15, April 4, 10, 18, 20, May 18, 20, June 29, July 31, Aug. 19, Sept. 15, Oct. 11, and Nov. 20. There seems to be practically no seasonal variation in color. The young, however, are markedly different from the adults, as is the rule in the present genus.

Named for Dr. Edgar A. Mearns, U. S. A., who first called my attention to the great differences between the present species and true *P. flavus.*

## **Peromyscus michiganensis pallescens,** subsp. nov.

*Peromyscus texanus* ALLEN, Bull. Am. Mus. Nat. Hist. VIII, 1896, p. 64 (not of Waterhouse).

*Adult.*—Above grayish brown, with a slight yellowish wash, mostly confined to the sides, strongly varied with dull blackish brown, especially along the median line, often forming a distinct broad blackish dorsal band; below clear grayish white, the tips of the hairs being white and the basal portion plumbeous; ears blackish brown, narrowly edged with white; tail sharply bicolor, upper third of its circumference blackish brown, rest white; feet white, with a faint buffy tinge.

*Young.* — Dull gray brown (dark 'mouse-gray') above, with a darker (blackish) median band; otherwise like the adult.

*Measurements.—Male* (type). Total length, 127; tail vertebræ, 52; hind foot, 16; ear (from dry skin), 11.

Nine adult males measure as follows: Total length, 126 (121–130); tail vertebræ, 51 (50–52); hind foot, 16 (15–17).

A single adult female is larger than the largest male of the series

*Type*, No. $\frac{12213}{10565}$, ♂ ad., San Antonio, Texas, Feb. 7, 1896; H. P. Attwater.

This subspecies is based on a series of 10 adults and 7 two-thirds grown young, all winter specimens (Dec. 14–March 19), taken mostly in January and February.

They are so different in color and size from a large series of *Peromyscus michiganensis* from Fort Snelling, Minn., collected by Dr. Mearns, that they would seem to be specifically distinct, were it not that a large series of winter specimens from Lawrence, Kansas, collected by Prof. L. L. Dyche, are so nearly intermediate, in both size and coloration, as to render it probable that *P. m. pallescens* is merely a pale, depauperate form of *P. michiganensis*.

The measurements of a series of adults from each locality compare as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| Fort Snelling.... | 3 ♂♂, 143 (144–146) | 56 (55–59) | 17.3 (17–18) |
| " .... | 5 ♀♀, 149 (144–153) | 57 (54–63) | 18.1 (18–18.5) |
| Lawrence..... | 10 ♂♂, 137 (130–149) | 51 (43–58) | 17.9 (16–19) |
| " .... | 5 ♀♀, 146 (137–153) | 57 (55–63) | 18 (16–19) |
| San Antonio .... | 9 ♂♂, 126 (121–135) | 51 (50–52) | 16 (14–17) |

The Kansas specimens are thus good intergrades, and are almost distinct enough to merit recognition in nomenclature;

they are rather nearer the Fort Snelling series than the San Antonio series.

In coloration *P. m. pallescens* bears a close general resemblance to *Peromyscus canus* Mearns, from the same locality, but can be readily distinguished by its relatively shorter tail and hind foot and much smaller size.

## Vespertilio incautus, sp. nov.

*Vespertilio* sp. ALLEN, Bull. Am. Mus. Nat. Hist. VIII, 1896, p. 71.

*Adult in Autumn.*—Above dull hair brown with a faint shade of olive, the fur becoming somewhat darker towards the base ; below grayish with a faint tinge of buff, the basal half or two-thirds of the fur abruptly darker. Ears and membranes very dark or blackish brown, the posterior edge of the wing membranes distinctly lighter, especially the inner half.

*Adult in Spring* (March).—Lighter, both above and below, with a slight yellowish cast above.

*Measurements.—Male :* Expanse of wings, 282 ; total length, 95 ; tail, 45. *Female :* Expanse of wings, 275 ; total length, 91 ; tail, 38 (?). (Collector's measurements from fresh specimen.)

*Male :* Fore arm, 42 ; 1st digit, to end of claw, 7 ; 2d metacarpal, 35 ; 3d metacarp. 40, its 1st phal. 13, its 2d phal. 20 ; 4th metacarp. 39, its 1st phal. 12, 2d phal. 11 ; 5th metacarp. 39, its 1st phal. 10, 2d phal. 8 ; tibia, 21 ; foot, 15 ; height of ear, 13 ; length of tragus, 8.

The female is slightly smaller.

*Skull.*—Male, length, 17 ; greatest width of brain-case, 9.

*Type*, No. $\frac{12214}{10566}$, ♂ ad., San Antonio, Texas, Oct. 10, 1896 ; H. P. Attwater.

This species is easily distinguished by its large size and peculiar coloration, being as large or larger than *V. velifer* of Mexico, but differing from it markedly in coloration, lacking wholly the reddish brown tint of the latter.

Compared with *V. lucifugus* from Hickman, Kentucky, and Raleigh, North Carolina, it is very much larger, the average difference in the length of the fore arm, in corresponding sexes, being from 5 to 7 mm., while the skull is fully one-third more massive.

This species is based on a series of 5 specimens taken at San Antonio, Texas, by Mr. Attwater, March 12 and Oct. 10. It is a

'house' bat, all of the specimens having been taken in the house, except one, which was caught in a barn.

### **Vespertilio chrysonotus,** sp. nov.

Ears large, black, in size and form similar to the ear in *Vespertilio evotis*. Wing membranes dark brown. Whole upper parts golden buff, the fur blackish at base, and the extreme tips lighter than the subapical zone; below pale buffy white, the fur blackish brown basally. Nose and edge of upper lip blackish, this color continued posteriorly, forming a dark line beneath the eye. Humerus, forearm, femur and tibia, whitish. The hair extends over the base of the interfemoral membrane about as in *V. evotis*.

*Measurements.*—Spread of wings, 230; total length, 72; length of tail, 26; hind foot, 10 (collector's measurements from the fresh specimen). Length of ear, 17; length of tragus, 10; forearm, 40; 1st digit to end of claw, 7; 2d metacarpal, 31; 3d metacarpal, 34, its 1st phalanx, 12, its 2d phal. 16; 4th metacarpal, 32, its 1st phal. 9, 2d phal. 9; 5th metacarpal, 33, its 1st phal. 9, 2d phal. 7; tibia, 18; foot, 9.

*Type*, No. 11645, ♀ ad., Kinney Ranch, Wyoming, July 21, 1895; W. W. Granger.

This species is based on a single specimen, which unfortunately lacks the skull. It differs from Dulzura (California) specimens of *V. evotis* in its golden-buff color, much longer fore arm, and much shorter tail. It evidently belongs to the *V. evotis* group, of which further material may show it to be merely a well-marked subspecies.

---

## DESCRIPTION OF PLATES.

PLATE X.—Head of *Rangifer terræ novæ*, ♂ ad., from photograph of a mounted specimen, owned by Dr. C. B. Parker.

PLATE XI.—Fig. 1, antler of *R. terræ novæ*, ♂ ad.; Fig. 2, antler of *R. terræ novæ*, ♀ ad.

Fig. 3.—Antler of *Rangifer grœnlandicus*, ♂ ad.; Fig. 4, antler of *R. grœnlandicus*, ♀ ad.

FIG. 6.—Antler of *Rangifer tarandus*, ♂ ad.

The antlers are all photographed to the same scale, and are all from specimens in the American Museum of Natural History.

# Article XV.—LIST OF MAMMALS COLLECTED BY MR. WALTER W. GRANGER, IN NEW MEXICO, UTAH, WYOMING AND NEBRASKA, 1895–96, WITH FIELD NOTES BY THE COLLECTOR.

By J. A. Allen.

During the seasons of 1895 and 1896 Mr. Granger was again associated (see this Bulletin, VII, p. 259) with the Museum Palæontological Expedition as a field assistant under Dr. J. L. Wortman, and was able to devote considerable time, especially during the season of 1895, to collecting the smaller mammals of the regions visited. The collections thus made number 500 specimens, representing 48 species and subspecies, several of which proved to be new to science and have been already described.[1] Although the collections were made at a number of widely separated localities, it seems best to present the general results under one title, with nominal lists of the species obtained at the principal points where collections were obtained.

The following general account of these localities is kindly furnished by Mr. Granger, to whom I am also indebted for field notes on many of the species.

"*Uncompahgre Indian Reservation, Utah.*—Altitude about 5000 feet. Consists for the most part of sandy bad-land country, rather thinly grassed, with a dense growth of 'grease-wood' and 'sage brush.' Both the White and Green Rivers pass through the Reservation, and are well wooded along the bottoms. A species of *Peromyscus* and a small species of *Tamias* [*T. minimus consobrinus*] were obtained along these rivers, but all the other specimens were collected in a large bad-land basin, ten miles west of the Colorado line, known as Kennedy's Hole."

---

[1] *Neotoma cinnamomea*, *Tamias wortmani* and *Spermophilus tridecemlineatus parvus*. See this Bulletin, VII, pp. 331, 335, 337.

Collections were made here from March 17 to June 4, 1895 (72 specimens), and include the following species :

Lepus nuttalli,
Thomomys clusius,
Perodipus longipes,
Neotoma cinnamomea,
Peromyscus auripectus,
Peromyscus texanus nebrascensis,
Cynomys leucurus,
Spermophilus 13-lineatus parvus,
Tamias wortmani,
Tamias leucurus,
Tamias minimus consobrinus,
Canis latrans.

"*Diamond Mountain, Utah.*—Altitude, 7000 feet. Country well grassed and watered, but very open. The only trees are a few scattered pines and aspens, confined to the higher ridges. The few specimens obtained here were taken at Pot Creek, which runs into Lodera Cañon, fifteen miles distant."

The only species collected here was *Peromyscus texanus arcticus*.

"*Brown's Park, Utah.*—Altitude about 7000 feet. The only specimens secured here were taken in a rocky cañon along Green River, fifteen miles above the head of Lodera."

Three specimens were obtained, one of which is referable to *Peromyscus truei*, and the others to *P. texanus nebrascensis*.

"*Kinney Ranch, Sweetwater Co., Wyoming.*—Altitude, 7500 to 8000 feet; 25 miles south of Bitter Creek station, on the Union Pacific Railway. Exceedingly dry, sandy and barren ; grease-wood and sage-brush grow thickly in certain localities. The country consists mostly of rough, rocky bad-lands, and long stretches of sandy, sage-covered alkali plains. In the immediate vicinity of Kinney Ranch is an alkaline marsh of some hundred acres or so in extent. This, aside from two or three other springs and a few water holes, is the only water found within fifteen miles of the ranch. The only mammal found in the marsh and not elsewhere was a species of *Microtus*."

Collections were made here from June 7 to August 15, 1895 ; the 304 specimens taken represent the following 15 species :

Lepus campestris,
Lepus nuttalli,
Thomomys clusius,
Perognathus fasciatus,
Neotoma cinnamomea,
Onychomys leucogaster brevicauda,
Peromyscus texanus nebrascensis,
Microtus pallidus,
Microtus, sp. inc.,
Spermophilus elegans,
Sperm. 13-lineatus parvus,
Tamias wortmani,
Tamias minimus consobrinus,
Vespertilio ciliolabrum,
Vespertilio chrysonotus.

"*Rife's Ranch, Utah.*—Altitude, 8000 feet; 20 miles south of Kinney Ranch. The country is practically the same as at Kinney Ranch."

During the single day's collecting here only *Spermophilus elegans* and *Onychomys leucogaster brevicauda* were taken.

"*Snake River, Colorado.*—Altitude, 7000 feet. This locality is 40 miles east of Kinney Ranch, at what is known as Cherokee Crossing of Snake River, 25 miles down the river from Bagg's post office. The river bottom is quite well wooded in places, and overgrown with brush. Otherwise the locality is much like the country at Kinney Ranch."

The only species taken here, during a short halt, was *Neotoma cinnamomea*.

"*Three Forks, Colorado.*—Altitude, 9000 to 9500 feet. This locality is 30 miles above Bagg's post office, on Snake River, in the lower edge of the pine belt. The river valley is thickly grown with deciduous trees. The specimens were taken near the river."

This locality is evidently on the edge of a fauna very distinct from that of the lower open country immediately to the westward. The 26 specimens taken during a day's stay at this camp represent the following species: *Tamias lateralis* (in place of *T. wortmani*), *Tamias quadrivittatus* (in place of *T. consobrinus*), *Neotoma orolestes* (in place of *N. cinnamomea*), and *Peromyscus texanus arcticus* (in place of *P. t. nebrascensis*). Also one specimen of *Onychomys leucogaster brevicauda* was taken.

*Elk Mountain, Wyoming.*—The five specimens collected at this camp represent *Neotoma orolestes* and *Peromyscus texanus articus*, and were taken on the overland stage trail at the base of the mountain, just at the edge of the pine belt.

"*Sherman, Wyoming.*—Altitude, 8900 feet. On the overland stage trail, 9 miles north of Sherman station, on the Union Pacific Railway. The specimens were taken in a grove of pines and spruces, except those of *Zapus* and *Microtus*, which were from a cultivated field in a clearing."

The 33 specimens taken here represent the following species:

Lepus grangeri,
Zapus, sp. inc.,
Microtus longicauda ?
Microtus, sp. inc.,
Neotoma orolestes,
Peromyscus texanus arcticus,
Tamias quadrivittatus,
Sciurus hudsonicus,
Sorex personatus.

"*Perch and Bassett, Rock Co., Nebraska.*—These localities are in the typical Nebraska sand hills. The specimens of *Microtus*, *Sorex* and *Blarina* were taken at a large marshy lake, near Perch post office."

The 132 specimens, collected Oct. 6–27, 1895, represent 12 species, as follows:

Perodipus longipes,
Perognathus fasciatus flavescens,
Microtus pennsylvanicus,
Microtus austerus,
Onychomys leucogaster,
Reithrodontomys dychei,
Peromyscus texanus nebrascensis,
Spermophilus obsoletus,
Spermophilus 13-lineatus pallidus,
Scalops argentatus,
Blarina brevicauda,
Sorex personatus haydeni.

"*Chaco Cañon, New Mexico.*—Very dry and sandy 'grease-wood country,' with a few cedars on the higher ridges. The specimens were taken in the cañons, about 20 miles east of the Navajo Reservation."

The 34 specimens taken here (June 11–26, 1896) represent a fauna allied to that of the Uncompahgre Indian Reservation, Utah, the following species being represented:

Lepus arizonæ,
Perodipus longipes,
Neotoma cinnamomea,
Onychomys leucogaster brevicauda,
Peromyscus auripectus,
Peromyscus rufinus,
Tamias leucurus.

Besides the above, the collection contains 8 specimens from Spring Creek, Nebraska (see this Bulletin, VII, p. 261), among which are 4 specimens of *Microtus haydenii*.

**1. Lepus campestris** *Bach.* PRAIRIE HARE.—One specimen, a half-grown male, taken at Kinney Ranch, July 15.

"Quite common in the vicinity of Kinney Ranch. Three specimens were seen on the Uncompahgre Indian Reservation, but none were met with in the intervening country, it being too mountainous."—W. W. G.

**2. Lepus arizonæ** *Allen.* ARIZONA COTTONTAIL.—A series of 5 specimens, from Chaco Cañon, northwestern New Mexico (head of San Juan basin), collected June 15–17, are referred to *L. arizonæ.*

**3. Lepus nuttalli** (*Aud. & Bach.*). SAGE HARE; SAGE COTTONTAIL.—A series of 7 adults from the Uncompahgre Indian Reservation, Utah (March 17–20 and May 4–6), and another series of 11 adults and 5 young (one-fourth to one-half grown) from Kinney Ranch, southwestern Wyoming (June 17–Aug. 1) seem nearly indistinguishable from another series from the Bad-lands (Corral Draw and vicinity) of South Dakota (May, July and August), previously recorded (this Bulletin, VII, p. 264) as *Lepus sylvaticus nuttalli.* They all have the long ears and greatly inflated audital bullæ of the *L. arizonæ* group, but are paler and of a more yellowish cast than true *L. arizonæ*, or than either of its subspecies (*minor* and *major*) lately recognized by Dr. Mearns (Proc. U. S. Nat. Mus., XVIII, 1896, p. 557). In general size, however, the Utah, Wyoming and South Dakota specimens are larger, and differ in coloration from *L. arizonæ* from the desert region of the Lower Colorado River in southeastern California, lacking the rufous tint of *arizonæ*, which is replaced by a very pale yellowish tint, shown even in the nape patch and legs. They also have the ears much more heavily clothed.

These specimens are provisionally referred to *Lepus nuttalli*, in the absence of material from the type locality of the latter for comparison.

The adults of the three series measure as follows:

| | Length. | Tail Vertebræ. | Hind Foot. | Ear from notch. |
|---|---|---|---|---|
| Uncompahgre, 1 ♂ | 400 | 45 | 95 | 64 |
| " 6 ♀♀ | 403 (386–420) | 45 (40–55) | 102 (100–110) | 66 (61–67) |
| Kinney Ranch, 6 ♂♂ | 361 (335–380) | 51 (49–55) | 90 ( 85– 92) | 55.3 (51–60) |
| " 5 ♀♀ | 410 (404–418) | 46 (40–54) | 96 ( 92–101) | 63 (61–65) |
| South Dakota, 2 ♂♂ | 372 (305–406) | 58 (44–71) | 92 ( 89– 95) | 56 (53–59) |
| " 3 ♀♀ | 397 (371–419) | 58 (51–63) | 92 ( 89– 95) | 59 (55–60) |

As usual in the Hares, the females exceed the males in size.

"Common at both Kinney Ranch and the Uncompahgre Indian Reservation. I have never seen Cottontails so abundant as at Kinney Ranch. On the Uncompahgre Reservation they were

confined to the rocks in spring while the snow remained, but later they were common enough in old burrows of Prairie Dogs and Badgers."—W. W. G.

4. **Lepus grangeri** *Allen.* GRANGER'S COTTONTAIL.—One specimen, ♂ ad., Sherman, Wyoming, Sept. 9. This example agrees well with the Black Hills form named by me *Lepus sylvaticus grangeri.* A further comparison with large series of the *L. sylvaticus* and *L. arizonæ* groups from various localities seems to show that *grangeri* is not intimately related to any other described form.

5. **Erethizon epizanthus** (*Brandt*). YELLOW-HAIRED PORCUPINE.—One specimen, skeleton, from Lost Cabin, Wyoming, Aug. 25.

"Three or four were seen at this locality. They frequent the vicinity of bad-lands, where they live in caves. To the north of Chaco Cañon, New Mexico, it was very common. In this locality nearly every piñon tree had had the bark eaten off from the upper limbs by these animals."—W. W. G.

6. **Thomomys clusius** *Coues.*—Two specimens, Uncompahgre Reservation (April 3 and May 3), both males; one is adult, the other slightly immature. They measure, respectively, total length, 193, 175; tail vertebræ, 58, 44; hind foot, 25, 23. Also 2 specimens, not fully grown, Kinney Ranch, July 21 and 23.

"Rather rare on the Uncompahgre Reservation, but fairly common at Kinney Ranch, where it inhabited the sandy stretches."—W. W. G.

7. **Perodipus longipes** (*Merriam*). MOKI KANGAROO RAT.—Represented by 23 specimens from the Uncompahgre Indian Reservation, Utah (collected March 20–May 5); 17 specimens from Kinney Ranch, Wyoming (July 25–Aug. 7); 15 specimens from Rock County, Nebraska (Oct. 8–22), and 3 specimens from Chaco Cañon, New Mexico (June 16).

I am surprised to find that the Nebraska specimens present no tangible differences from those from Utah and Wyoming; they differ decidedly, however, in much paler coloration from a large series of *Perodipus richardsoni* from Beaver County, Oklahoma (Oct. 12-26). The latter is probably merely a subspecies of *P. longipes*, which is the earlier name for the group.

Throwing out a few obviously immature specimens, the measurements are as folllows :

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| Utah..... | 11 ♂♂, 256 (243–275) | 143 (139–151) | 41.5 (39–43) |
| " ..... | 8 ♀♀, 254 (235–271) | 141 (130–144) | 41.3 (40–42) |
| Wyoming.... | 6 ♂♂, 258 (235–278) | 144 (138–159) | 42 (40–44) |
| " ... | 4 ♀♀, 255 (243–272) | 146 (138–160) | 41.5 (39–43) |
| Nebraska.... | 10 ♂♂, 253 (240–272) | 145 (134–158) | 42 (41–43) |
| " .... | 3 ♀♀, 253 (240–261) | 139 (135–142) | 41.7 (41–42) |

A small series from Custer County, South Dakota, previously referred to *P. richardsoni* (this Bulletin, VII, p. 265), evidently belong to the *longipes* type.

"Common throughout the Uncompahgre Reservation. At Kinney Ranch I found them only in the sand dunes, and associated with *Spermophilus parvus*."—W. W. G.

**8. Perognathus fasciatus** (*Wied*). MAXIMILIAN'S POCKET MOUSE.—Two specimens, ♂ and ♀, full grown but rather young, collected at Kinney Ranch, Wyoming, July 21 and 23, I am unable to distinguish subspecifically from Montana and South Dakota (eastern base of the Black Hills) examples of *P. fasciatus*. This extends the range of the *P. fasciatus* group far to the west of previously reported localities, and into the Green River basin.

These specimens measure: Total length, ♂ 126, ♀ 134; tail vertebræ, ♂ 68, ♀ 69; hind foot, ♂ 19, ♀ 18.

"Taken in the sand hills, and the only ones seen, although I trapped especially for them."—W. W. G.

**9. Perognathus fasciatus flavescens** *Merriam*. NEBRASKA POCKET MOUSE.—Represented by 8 full-grown specimens from Perch, and 2 from Basset, Rock Co., Nebr., collected Oct. 3–27. The 6 males measure: Total length, 122 (115–127); tail vertebræ, 61 (58–64); hind foot, 17 (16–18). The four

females are slightly smaller, measuring: Total length, 121 (117–125); tail vertebræ, 58 (57–59); hind foot, 16.5 (15–17).

**10. Zapus,** sp. inc. JUMPING MOUSE.—One specimen, ♀, Sherman, Wyoming, Sept. 10. Length, 211; tail vertebræ, 125; hind foot, 29.

This specimen is very unlike any described form of this genus, and differs from any specimens I have seen from any other locality, in having the sides of the body very light yellowish, in very strong contrast with the nearly black dorsal area.

**11. Microtus (Lagurus[1]) pauperrimus** *Cooper.* PALLID MEADOW MOUSE.—Two specimens, collected at Kinney Ranch, July 23 and 24, seem referable here, agreeing closely with Dr. Merriam's description (N. Am. Fauna, No. 5, July, 1891, p. 64) of examples from the Salmon River Mountains, Idaho. These specimens measure respectively as follows: No. $\frac{11137}{9431}$, ♂ ad., total length, 118; tail vertebræ, 24; hind foot, 16. No. $\frac{11138}{9432}$, ♀ ad., total length, 108; tail vertebræ, 24; hind foot, 16.

"The two specimens were taken from the same burrow in a sand hill near Kinney Ranch."—W. W. G.

**12. Microtus (Pedomys) haydenii** (*Baird*). HAYDEN'S MEADOW MOUSE.—Four specimens, 3 adult males, 1 adult female, Spring Creek, Custer Co., South Dakota, June 12, Nov. 12 and Dec. 12. Although taken at different seasons, they all agree closely in coloration. They also agree with the single specimen previously recorded (this Bulletin, VI, 328) from the same locality. They measure as follows: Total length, 153 (132–164), tail vertebræ, 33 (27–37); hind foot, 20 (19–21).

**13. Microtus (Pedomys) austerus** (*Le Conte*). PRAIRIE MEADOW MOUSE.—Represented by 7 specimens from Perch, Rock Co., Nebraska, Oct. 26–28. The five adults (3 ♂♂, 2 ♀♀) measure as follows: Total length, 141 (135–154); tail vertebræ, 33 (31–35); hind foot, 20 (19–20.5).

"All were taken in dry sandy ground bordering a cornfield. It was common at that particular locality."—W. W. G.

[1] *Cf.* Merriam, Am. Nat., XXIX, p. 758, Aug., 1895.

**14. Microtus (Microtus) pennsylvanicus** (*Ord*). EASTERN MEADOW MOUSE.—A series of 19 specimens, from Perch, Nebraska, Oct. 5–20, do not differ appreciably from *M. pennsylvanicus* from the East. Of 19 specimens, 15 are in adult pelage, though doubtless not all fully adult in size. They measure as follows:

| | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 7 ♂ ♂ | 153 (138–161) | 41 (34–48) | 21 (20–22) |
| 8 ♀ ♀ | 154 (140–179) | 38 (35–49) | 21 (20–22) |

**15. Microtus (Microtus) longicauda?** (*Merriam*). LONG-TAILED MEADOW MOUSE.—Two specimens from Sherman, Wyoming, Sept. 11, are doubtfully referred to this species. One is a young adult, the other an old adult, with the tail mutilated.

**16. Microtus (Microtus)**, sp. inc.—The 12 specimens included under the above heading are from the following localities: Sherman, Wyoming, Sept. 10 and 11, 3 specimens; Laramie, Wyoming, Sept. 8, 5 specimens; Kinney Ranch, Wyoming, July 10–Aug. 15, 4 specimens. All but 4 are more or less immature, some being quite young. The 4 adults (3♀♀, 1 ♂) measure as follows: Total length, 139 (131–146); tail vertebræ, 36.5 (33–40); hind foot, 18.5 (17–20).

"The specimens from Kinney Ranch were all taken in the alkali marsh previously mentioned, and so were rather rare at this locality"—W. W. G.

**17. Neotoma cinnamomea** *Allen.* FULVOUS WOOD RAT.

*Neotoma cinnamomea* ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 331. (Separates published Nov. 8, 1895.)

As already stated (l. c.), this species is represented by 31 specimens from Kinney Ranch, Wyoming, taken July 6–Aug. 6; and 2 from Uncompahgre Indian Reservation, Utah, April 2 and 9. To the same species I refer 3 specimens since received from Chaco Cañon, northwestern New Mexico, collected June 18–23, 1896.

This species proves to be very different from *N. rupicola* of the Bad-lands of South Dakota, differing in important cranial char-

acters, as well as in size, though the two forms bear a very close resemblance to each other externally. It is also very different from *N. orolestes.*

"Found throughout the Washakie bad-lands and Uinta Basin, wherever the country is rough enough to suit their habits, which are the same as those of *N. rupicola*" (see this Bulletin, VII, p. 270).—W. W. G.

**18. Neotoma rupicola** *Allen.* BAD-LANDS RAT.—Three specimens, Spring Creek, South Dakota, Dec. 17 and Feb. 17 and 19. These, though in winter pelage, differ very little from September specimens, except that the pelage is fuller.

**19. Neotoma orolestes** *Merriam.* MOUNTAIN WOOD RAT.—I refer provisionally to this species 1 specimen from Elk Mountain, Wyoming (Sept. 7); 5 from Sherman, Wyoming (Sept. 9, 10); 4 from Snake River, northwestern Colorado (Aug. 25, 26); and 2 from Three Forks, northwestern Colorado (Sept. 2). They agree in much larger size, larger amount of black in the dorsal pelage, and grayer nose, in comparison with *N. cinnamomea*, and in these features they approach *N. orolestes*, described from a little further south in the mountains of Colorado (type locality of the species, Saguache Valley). While resembling this species in color, they average rather smaller than the measurements given for the type of the species. The 10 adults from the localities above named measure as follows:

| | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 6 ♂♂ | 392 (382–394) | 167 (158–182) | 43 (40–45) |
| 4 ♀♀ | 357 (344–365) | 154 (147–160) | 41 (40–41) |

The corresponding measurements for the same number of examples of *N. cinnamomea* are as follows:

| | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 6 ♂♂ | 364 (356–368) | 158 (151-163) | 41 (40–43) |
| 4 ♀♀ | 343 (337–351) | 148 (144–150) | 39 (37–41) |

"Apparently a common animal at the localities where specimens were taken."—W. W. G.

**20. Peromyscus truei** (*Shufeldt*). True's Cliff Mouse.—One specimen, ♀ adult, Brown's Park, northeastern Utah, June 15. Apparently identical with specimens from near the type locality in New Mexico.

"Taken from a nest of *Neotoma cinnamomea*, in a high cliff."—W. W. G.

**21. Peromyscus auripectus** *Allen.* Silky Cliff Mouse.—Uncompahgre Indian Reservation, April 2 and 3 and May 10; 4 specimens, all adult. They are nearly indistinguishable in coloration and size from the type series of the species from Bluff City, southeastern Utah (May 8–17). Three of the four specimens have the fulvous pectoral spot strongly developed.

Chaco Cañon, San Juan region, northwestern New Mexico, June 7 and 8; 4 specimens, all adult males. These all lack the fulvous pectoral spot, but are otherwise like the Bluff City series in coloration, though slightly larger.

In measurements these three series compare as follows:

| | | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|---|
| Bluff City | 5 ♂♂, 5 ♀♀ | 171 (167–181) | 92 (85–98) | 22.3 (22–24) |
| Chaco Cañon | 4 ♂♂ | 175 (171–180) | 92 (90–95) | 22.1 (22–23) |
| Uncom. Ind. Res. | 4 | 167 (159–176) | 89 (86–92) | 22.2 (22–23) |

"Relatively much less common than the other species of *Peromyscus* which were found associated with it, the ratio, as determined by trapping, being about as 1 to 5. I have always found it confined to rocky places. In Chaco Cañon the Pueblo ruins were its favorite abode."—W. W. G.

**22. Peromyscus texanus nebrascensis** (*Mearns*). Fulvous White-footed Mouse.—This species is represented by a large number of specimens, from a wide range of localities, as follows: Uncompahgre Indian Reservation, Utah, May 1–June 1; 11 specimens, 8 adult and 5 young. Kinney Ranch, Wyoming, June 15–Aug. 5; 60 specimens, about one-half adult. Perch, Rock Co., Nebraska, Oct. 7–24; 14 specimens, 6 adult.

The Nebraska specimens have smaller ears than those from Utah and Wyoming, and are much brighter colored, but the color

differences may be in part due to season. The series, however, is too small for satisfactory comparison. The adults of these series measure as follows :

| | | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|---|
| Uncom. I. Res | 4 ♂♂, | 149 (142–160) | 63 (59–70) | 19.8 (19–20) |
| " " | 2 ♂♂, | 165 (159–170) | 70 (60–75) | 21 (20–22) |
| Kinney Ranch | 8 ♂♂, | 159 (147–172) | 71 (65–74) | 19 (19–21) |
| " " | 16 ♀♀, | 159 (154–173) | 76 (66–78) | 19.8 (19–20) |
| Perch, Nebr. | 1 ♂, | 161 | 65 | 19 |
| " " | 2 ♀, | 160 (156–165) | 62 (61–63) | 19 (19–19) |

**23. Peromyscus texanus arcticus** (*Mearns*). Northern White-footed Mouse.—To this form are referred 3 immature specimens from Diamond Mountain, Utah, June 15 ; 8 specimens (all adult) from Three Forks, northwestern Colorado, Sept. 2 ; 5 specimens (adult) from Fort Steele, Wyoming, Sept. 2 ; 4 specimens (all nearly adult) from Elk Mountain, Wyoming, Sept. 7 ; 5 specimens (young adults) from Sherman, Wyoming, Oct. 10. They are not quite typical, but belong here rather than elsewhere. As they are nearly all young adults, it is hardly worth while to give the measurements.

**24. Peromyscus rufinus** *Merriam.*—A series of 13 specimens, all but 3 fully adult, from Chaco Cañon, northwestern New Mexico (June 11–22). They are the same as the Rowley series from practically the same locality, recorded first as *Sitomys sonoriensis* (this Bulletin, V, 1893, p. 74), and later (this Bulletin, VII, 1895, pp. 232–234) as *Peromyscus leucopus rufinus*. For comparison with the measurements already published (l. c., p. 234) the following may be added: 4 ♂♂, 6 ♀♀ = 10; length, 161 (150–173); tail vertebræ, 67 (63–77); hind foot, 19.7 (19–20).

"The Puerco ruins in Chaco Cañon, near our camp, were overrun with these mice. I have never seen any species of mouse so abundant at any other locality. They were associated with *P. auripectus*."—W. W. G.

**25. Reithrodontomys dychei** *Allen.* Dyche's Harvest Mouse.—A series of 23 specimens of *Reithrodontomys*, ranging in age from nursing young to adults, from Perch, Rock Co., Nebr., (Oct. 3–26), seem better referable to *R. dychei* than to the more western *R. dychei nebrascensis*.

"Very common, and found in all sorts of locations. I found nests of this species containing nursing young as late as Oct. 29." —W. W. G.

**26. Onychomys leucogaster** (*Wied*). EASTERN GRASSHOPPER MOUSE.—Represented by 20 specimens from Perch, Rock Co., Nebraska, collected Oct. 3–25. All but three or four appear to be fully adult. The measurements are:

| | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 8 ♂ ♂ | 141 (139–148) | 39 (36–41) | 20.6 (20–21) |
| 8 ♀ ♀ | 142 (135–146) | 39.4 (36–45) | 21 (20–22) |

"A common mouse at Perch, where it was especially abundant in old fields."—W. W. G.

**27. Onychomys leucogaster brevicauda** *Merriam.* IDAHO GRASSHOPPER MOUSE.—A series of 22 specimens, all but 6 more or less immature (many are little more than half grown), is provisionally referred to this species. All but three were taken at Kinney Ranch, June 29 to Aug. 5—the others at Rife's Ranch, June 17. A specimen from Three Forks, northwestern Colorado, collected Sept. 1, is referred also to the same form. Also two examples from Chaco Cañon, northwestern New Mexico, taken June 16.

The chief difference between the above-mentioned specimens and typical *O. leucogaster* consists in their very noticeably larger ears.

Three adult males and 4 adult females from Kinney Ranch measure as follows:

| | Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 3 ♂ ♂ | 136 (132–143) | 37 (35–40) | 20 (19–21) |
| 4 ♀ ♀ | 132 (120–141) | 37 (32–38) | 20 (19–20) |

Another specimen, in the same lot, but not included in the foregoing measurements, has a much longer tail, measuring as follows: Length, 146; tail vertebræ, 50; hind foot, 20.

"Very common at Kinney Ranch, and found in the same burrows with *Spermophilus elegans*. At Three Forks, Colorado, the single specimen taken was the only one seen, the locality apparently being not suited to the needs of this species."—W. W. G.

**28. Cynomys leucurus** *Merriam.* WHITE-TAILED PRAIRIE DOG.—One specimen, Uncompahgre Indian Reservation, ♀ ad., April 28.

"Quite common at Kinney Ranch and Uncompahgre Reservation. I also observed colonies at Baggs, Rawlins, Fort Steele, and Laramie City, Wyoming.

"The first examples of *Cynomys ludovicianus* met with on our wagon journey east were seen at the base of the Laramie Mountains, 25 miles west of Cheyenne."—W. W. G.

**29. Spermophilus elegans** *Kennicott.* WYOMING SPERMOPHILE.—A series of 35 specimens from Kinney Ranch, Bitter Creek, Wyoming, June 17–July 12, consists largely of immature examples, varying in age from less than one-quarter grown to nearly full size. The unquestionably adults of the series measure as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 7 ♂ ♂ | 270 (251–283) | 69 (67–76) | 41 (39–42) |
| 6 ♀ ♀ | 268 (256–277) | 68 (64–74) | 40 (40–41) |

"First observed at Brown Park. It is an exceedingly abundant animal, and a nuisance where any attempt at farming is made. It evidently retires to its burrows very early in the season, as I did not see a single individual after the 20th of August."—W. W. G.

**30. Spermophilus obsoletus** *Kennicott.* KENNICOTT'S SPERMOPHILE.—One specimen, ♂ ad., from Perch, Rock Co., Nebraska, Oct. 6.

"This was the only individual seen, and I was informed by residents at Perch that it was rare in this locality."—W. W. G.

**31. Spermophilus tridecemlineatus pallidus** *Allen.* PALE STRIPED SPERMOPHILE.—One specimen, ♂ ad., Perch, Rock Co., Nebraska, Oct. 6, 1895.

**32. Spermophilus tridecemlineatus parvus** *Allen.* SMALL STRIPED SPERMOPHILE.

*Spermophilus tridecemlineatus parvus* ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 337 (Separates published Nov. 8, 1895).

Represented by 2 specimens from the Uncompahgre Indian Reservation, Utah, and 9 from Kinney Ranch, Wyoming, as already recorded (l. c.).

"This species was restricted to the sand dunes in a bad-land basin near Kinney Ranch, and to a similar locality in Kennedy's Hole."—W. W. G.

**33. Tamias wortmani** *Allen.* WORTMAN'S CHIPMUNK.

*Tamias wortmani* ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 335 (Separates published Nov. 8, 1895).

As previously recorded (l. c), this species is represented by a series of 58 specimens, collected at Kinney Ranch, Wyoming.

"Common throughout the Washakie bad-lands, but not generally distributed, being confined to rough and rocky places."—W. W. G.

**34. Tamias lateralis** (*Say*). SAY'S CHIPMUNK.—One specimen, ♀ ad., Three Forks, northwestern Colorado, Sept. 1. This is a quite typical example of the species.

**35. Tamias leucurus** *Merriam.* ANTELOPE CHIPMUNK.—Represented by 11 specimens, collected in the Uncompahgre Indian Reservation in Utah, March 17–May 19, mostly in worn breeding pelage. They seem quite indistinguishable from topotypes of this species, collected at corresponding seasons. They consequently differ markedly from a perfectly comparable series of *T. l. cinnamomeus* from the San Juan region of southeastern Utah, to which they would seem, on geographical grounds, more nearly allied. They measure as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 6 ♂ ♂ | 213 (203–221) | 60 (50–68) | 39.8 (38–42) |
| 4 ♀ ♀ | 216 (205–232) | 64 (62–68) | 39 (35–40) |

Four specimens from Chaco Cañon, New Mexico, June 17 and 18, are also referred to this form.

"Common on the Uncompahgre Reservation, and one of the most conspicuous animals at Chaco Cañon, New Mexico. I observed them from the Rio Puerco westward to the Navajo Reservation."—W. W. G.

**36. Tamias minimus consobrinus** *Allen.* WAHSATCH CHIPMUNK.—Represented by 46 specimens, all collected at Kinney Ranch, Wyoming, June 7–Aug. 8. Many of the July specimens were in molt when taken, portions of the old breeding pelage being mixed with the new coat. Most of the July and August specimens had completed the molt. The adults, before molting, become very much faded and worn, losing nearly all of the bright tints that characterize the post-breeding pelage. The males, as usual in this and allied genera, molt considerably earlier than the females. The adults of the series measure as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 14 ♂ ♂ | 186 (176–194) | 86 (77–93) | 29.3 (27–31) |
| 22 ♀ ♀ | 191 (176–195) | 86 (79–93) | 29.5 (27–30) |

"Common throughout the entire Washakie bad-lands. Occurs with *T. wortmani*, but the latter is not so generally distributed."—W. W. G.

**37. Tamias quadrivittatus** (*Say*). COLORADO CHIPMUNK.—A series of 11 specimens, collected at Sherman, Wyoming, Sept. 9–11, are distinctly referable to this form of the *quadrivittatus* group. They measure as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 5 ♂ ♂ | 192 (186–195) | 84 (78–90) | 32 (31–34) |
| 6 ♀ ♀ | 194 (191–197) | 84 (78–89) | 31.7 (30–33) |

A series of 16 specimens from Three Forks, northwestern Colorado (30 miles above Bagg's Crossing), collected Sept. 1–2, are also referred to *T. quadrivittatus*, although not typical. They are a little larger, with a slightly smaller hind foot, considerably darker in color, and have a much narrower, slenderer tail. The dark stripes are blacker, and the median light stripes grayer (less white), and the sides are duller rufous than in true *T. quadrivittatus*. The differences, however, are hardly enough pronounced to render their recognition in nomenclature desirable. This series measures as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 10 ♂ ♂ | 190 (188–195) | 85 (81–89) | 29.5 (28–30) |
| 5 ♀ ♀ | 198 (188–204) | 88 (84–93) | 30.7 (30–31) |

"An exceedingly common Chipmunk at both Sherman and Three Forks."—W. W. G.

**38. Sciurus hudsonicus** (*Erxl.*). CHICKAREE.—Three specimens from Sherman, Wyoming, collected Sept. 9–11, represent a pale phase of *S. hudsonicus*, not, however, sufficiently different from the eastern type to be separable as a subspecies. In some features the specimens grade slightly toward *S. h. richardsoni*.

**39. Vespertilio ciliolabrum** *Merriam.* LITTLE PALE BAT.—Two specimens, males, Kinney Ranch, Wyoming, Aug. 1 and 3.

"Small bats were fairly abundant about the spring at Kinney Ranch, but I am unable to say which of the species taken was the most common."—W. W. G.

**40. Vespertilio chrysonotus** *Allen.* GOLDEN-BACKED BAT.—One specimen, Kinney Ranch, July 21. (See *antea*, p. 240.)

**41. Scalops argentatus** *Aud. & Bach.* SILVERY MOLE.—One specimen, ♂ ad., Perch, Rock Co., Nebraska, Oct. 6.

**42. Blarina brevicauda** (*Say*). SHORT-TAILED SHREW.—Four specimens, 2 adult males and 2 adult females, Perch, Rock Co., Nebraska, Oct. 6–26.

"A rather rare species along the lake at Perch."—W. W. G.

**43. Sorex personatus** *Geoffroy St. Hilaire.* EARED SHREW.—Represented by an adult female, taken at Sherman, Wyoming, Sept. 9.

**44. Sorex personatus haydeni** (*Baird*). HAYDEN'S SHREW.—Represented by 4 specimens from Bassett (Oct. 4) and 10 from Perch (Oct. 9–15), Rock Co., Nebraska. About one-half are in winter coat, a few are still in summer coat, and the rest represent intermediate stages between the two pelages. The series measures as follows :

| | Total Length. | Tail Vertebræ. | Hind Foot. |
|---|---|---|---|
| 6 ♂ ♂ | 96 (86–100) | 35.5 (30–38) | 12 (11.5–13) |
| 7 ♀ ♀ | 92 (88–98) | 36.5 (29–38) | 11.5 (11–12) |

"Found in the same localities as *Blarina brevicauda*, but much more common."—W. W. G.

**45. Taxidea taxus** (*Schreber*). BADGER.—One skull, Otto, Wyoming, Aug. 1.

**46. Canis latrans** *Say*. PRAIRIE WOLF; COYOTE.—A litter of 4 young, Uncompahgre Indian Reservation, Utah, March 22. Also 1 skull, Otto, Wyoming.

**47. Canis nubilus** *Say*. GRAY WOLF; TIMBER WOLF.—Two skulls, Otto, Wyoming.

**48. Lynx rufus** *Raf*. BAY LYNX.—Two specimens, Otto, Wyoming, Aug. 1.

"Very abundant in the Big Horn Basin. Individuals were seen along the creek and on the sage-brush flats nearly every day."—W. W. G.

# Article XVI.—PSITTACOTHERIUM, A MEMBER OF A NEW AND PRIMITIVE SUBORDER OF THE EDENTATA.

By Dr. J. L. Wortman.

The explorations of the Museum palæontological party in the Basin of the San Juan of New Mexico, during the past summer, secured, among other important materials, the larger part of an anterior limb of *Psittacotherium multifragum* Cope, associated with the lower jaws and a number of the upper teeth. The exact locality in which the specimen was found is near the head of the Cañon Escavada, in the upper horizon of the Puerco formation. The specimen in question was found by the writer, and, with the exception of a few unimportant weathered fragments, was bedded in its original matrix, a soft, friable, reddish-colored clay. The jaws and limb were not more than a foot or eighteen inches apart, so there can be very little doubt that they belong to one and the same individual. It may be further added that no other remains were found within several hundred feet of them.

Since the specimen in question presents characters of such unusual interest and importance, I have thought it advisable to give this brief preliminary account, which will be followed by a more exhaustive description, together with a critical review of the allied forms, copiously illustrated.

It has been the custom of palæontologists to place the genus *Psittacotherium*, after Cope, in the Tillodontia, but I will endeavor to show that it not only has no relationship with that group, but that with the genera *Hemiganus*, *Ectoganus* and *Stylinodon* it forms a closely connected and consecutive series ancestral to and leading directly to the Gravigrada or Ground Sloths. A second series, composed of *Onychodectes* and *Conoryctes* is clearly an allied group which probably led to the Armadillos.

These two series I herewith arrange under a new suborder, for which I propose the name Ganodonta, constituting a primitive division of the Edentata. It may be defined according to our

present knowledge as follows : Primitive Edentates, characterized in the earlier forms by rooted teeth with divided fangs having a more or less complete enamel investment, in the later forms by the teeth becoming hypsodont, rootless, of persistent growth, and by limitation of the enamel to vertical bands in progressive decrease. They are further characterized by the presence of incisors in both jaws, by a typical molar and premolar dentition, by a trituberculate molar crown, which disappears early in life through wear, leaving the dentine exposed.

Of this suborder there are two families, viz. : Conoryctidæ, including *Conoryctes* and *Onychodectes*, and Stylinodontidæ, including *Hemiganus*, *Psittacotherium*, *Ectoganus* and *Stylinodon*. The lower Puerco representatives of these two families approach one another closely, the tooth structure of *Hemiganus*, *Onychodectes* and *Conoryctes* being very similar. *Hemiganus*, however, displays a type of lower jaw which, together with the foot structure, clearly foreshadows *Psittacotherium*, which in turn is undoubtedly the forerunner of *Ectoganus* and *Stylinodon*. This family would then be characterized by having a remarkably short, deep, and heavy lower jaw with an enormously developed coronoid process reaching even with, or in advance of, the posterior termination of the tooth-line. The fore foot is short, with remarkably abbreviated, deeply excavated first and second phalanges (unknown in *Hemiganus*), together with a powerful, highly compressed, deep claw ; to this should be added a highly characteristic shortening of the facial portion of the skull. The Conoryctidæ, on the other hand, have more lengthened and slender lower jaws without special enlargement of the coronoid, elongated facial region of the skull, with much smaller and more rounded claws.

## Family STYLINODONTIDÆ *Marsh.*

The genera of this family, with their definitions, are as follows :

Crowns of upper canines encased in enamel ; canines not growing from persistent pulps ; lower incisors faced with enamel ; lower molars and premolars rooted with divided fangs and enamel-covered crown..... .. .....*Hemiganus* Cope. Lower Puerco.

Crowns of upper canines with enamel confined to anterior face; canines not growing from persistent pulps; lower incisors faced with enamel; lower molars and premolars rooted with fangs connate, and enamel-covered crowns..*Psittacotherium* Cope. Upper Puerco.

Crowns of superior canines with enamel confined to anterior face; canines growing from persistent pulps; lower incisors without enamel; lower molars and premolars with connate fangs; enamel confined to vertical bands on inferior premolars.....
*Ectoganus* Cope. Wahsatch.

Crowns of canines unknown, growing from persistent pulps; all lower teeth rootless, growing from persistent pulps; enamel of all lower molars and premolars confined to vertical narrow bands.....
*Stylinodon* Marsh. Bridger.

Of the limb of *Psittocotherium*, there are preserved the ulna and radius, the lunar, unciform, the greater part of the magnum, together with the third and fourth metapodials bearing their respective phalanges. The median and proximal phalanges of the second digit, with a part of the claw, are also preserved. On comparison of these bones with the corresponding parts of *Mylodon robustus*, the likeness is seen to be so striking that one would have scarcely any hesitancy in referring them to the same family. The metapodials are unusually short, which, with the two proximal phalanges, hardly exceed the claw in length. The proximal and median phalanges are short, robust, and deeply excavated at their articular extremities; the claws are enormously developed, somewhat compressed from side to side, with a marked curvature upon their dorsal surface. The third and fourth metapodials exhibit the same relations to each other and the carpal bones as do those of *Mylodon*, with a few unimportant exceptions. The ulna and radius are also strikingly megatheroid.

The evidence of the Edentate affinities of this suborder may be briefly summed up as follows: In the Stylinodontidæ the facial part of the skull is short, the incisors have undergone gradual diminution, the canines were enlarged as in *Megalonyx*, all the teeth finally came to be rootless and grew from persistent pulps, and what is yet most significant, the enamel came to be limited to narrow vertical bands with strong tendency to progressive disappearance, as is seen in the tusks of the earlier Proboscidea. The structure of the fore limb, so far as we know it, is almost identical with that of the large Ground Sloths; the distal end of the femur shows marked flattening, and the head of the humerus

displays that peculiar pyriform pattern so highly characteristic of the South American Edentata.

In the Conoryctidæ there is the same evidence of the weak development of the enamel, accompanied by loss of incisors. The skeleton, so far as known, shows many striking similarities to that of the Armadillos, of which this family is in all probability ancestral. It would appear, therefore, and I think the proposition is now susceptible of demonstration, that the South American Edentata originated in this country, that they migrated from North America before the close of the Eocene period, and did not appear in South America until late in the Eocene or early in the Miocene time. Collateral evidence of this migration to the southward in the Eocene is seen in the disappearance of *Menisco-therium* of the New Mexico Wahsatch and the appearance of its allies, the Proterotheriidæ, later in South America.

## Article XVII. — ON MAMMALS FROM THE SANTA CRUZ MOUNTAINS, CALIFORNIA.

By J. A. Allen.

The collections forming the basis of the present paper were made at Portola and La Honda, in San Mateo County, California, two small towns in the Santa Cruz or Coast Range of mountains. Portola is on the western slope, La Honda is on the eastern slope, the two localities being only about ten miles apart. The La Honda Collection was made during the week ending Jan. 2, 1895, by Messrs. W. W. Price and R. L. Wilbur, and numbers 236 specimens; the Portola Collection was made March 13 to April 16 (both inclusive), 1895, by Messrs. R. L. Wilbur and J. Diefenbach, for Mr. Price, and numbers about 400 specimens. I am indebted to Mr. Price for the opportunity of studying the entire series of about 650 specimens, of which about one-third was purchased by the Museum.

As the number of species contained in these collections is small, the common species are represented in large series, thus furnishing valuable information respecting the range of individual variation. The annotations given below relate mainly to this feature.

**1. Lepus trowbridgei** *Baird.*—Six specimens, collected at Portola, March 24–26.

**2. Perognathus californicus** *Merriam.*—Two specimens, Portola, March 25.

**3. Thomomys bottæ** (*E. & G.*).—Six specimens from Portola, collected March 23–April 3, present the following measurements:

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 4 ♂ ♂ . . | 244 (215–270) | 66 (56–82) | 30 (28–33) | 7.4 (5–10.5) |
| 2 ♀ ♀ . . | 208 (206–210) | 51.5 (51–52) | 25.5 (25–26) | 8 (8– 8) |

4. **Neotoma fuscipes** *Baird.*—This series includes about 50 specimens from La Honda, taken Dec. 25–Jan. 3, and about 100 from Portola, taken March 15–April 17. The La Honda specimens are all adult; the Portola series includes 4 immature examples, one of which is very young (less than one-fourth grown), and the other three are still in the plumbeous pelage, though nearly full grown.

This series of 150 specimens, from practically the same locality and taken at nearly the same season, is of interest as throwing light on the normal range of variation in respect to coloration, size, etc. The series from the two localities are practically indistinguishable as regards coloration; the slight apparent difference in measurements is doubtless due to the fact that the measurements of the two series were taken by different persons.

The larger or Portola series will be taken as the basis of the following comment.

*Young.*—The single very young specimen is similar in coloration to the nearly full-grown young, except that the dorsal surface is more profusely lined with black, giving a more blackish general effect. The full-grown young (total length, 335 to 359) vary from ashy plumbeous to dusky plumbeous, with a faint wash of pale buff on the sides and over the abdomen.

*Adult.*—Between the young examples just described and the next stage there is a wide gap as regards age, the rest of the series being all 'adult,' but the specimens may perhaps be roughly distinguished as 'young' adults, 'middle-aged' adults, and 'old' adults, on the basis of size and coloration. The smaller specimens, as a rule, are less rufous above, and less washed with fawn or reddish buff over the abdominal region. The younger specimens are generally yellowish brown above strongly lined with black, the middle of the dorsal area being often quite blackish, and the rest of the upper surface rather faintly yellowish brown. Below, the breast and anal region are white with a faint yellowish cast; abdominal area more or less washed with fawn color, the fur dusky at base. From this phase there is every gradation to the obviously 'old' adults, in which the whole upper surface is more or less strongly reddish brown,

with much less black, and the lower surface, particularly the abdominal area, is rather strong fawn color, or even ochraceous buff. It is evident, however, that while this rather wide variation in color is largely due to age, there is also a wide range of individual variation, as some of the young adults are quite strongly reddish brown above, while some very old specimens almost altogether lack the reddish suffusion above and the fawn color below. Thus in some obviously old specimens the lower parts are white, or yellowish white, while in others the whole lower parts, including the breast, throat and anal region, as well as the abdomen, are deeply suffused with fawn, with in some cases the abdomen strongly ochraceous buff.

*Feet.*—The fore feet as a rule are white to the wrists, and the hind feet have the toes white to the base ; but the white on the upper surface of the hind feet is frequently restricted to the apical half of the toes, but also frequently extends over the whole upper surface of the metatarsus, which is thus white or grayish white, with, of course, in different specimens, every intermediate stage.

There is no appreciable sexual difference in coloration, although the brightest colored specimens seem to be more frequently males than females. There is, however, a slight sexual difference in size, as shown by the following summary of measurements.

*Measurements.*—The series falls about equally on either side of a dividing line based on a total length of 420 mm. Of the La Honda series of 46 specimens—29 males and 17 females—25 exceed a total length of 420, and 21 fall below this measurement, divided sexually as follows : above 420, 20 males and 5 females ; below 420, 9 males and 12 females.

Of the Portola series of 87 specimens—47 males and 40 females—39 exceed 420 and 48 fall below 420, divided sexually as follows : above 420, 27 males and 12 females ; below 420, 20 males and 28 females.

*La Honda Series.*—The La Honda series presents the following averages and extremes :

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 29 ♂ ♂ | 429 (388–480) | 213 (192–230) | 44 (41–46) | 31.6 (30–35) |
| 17 ♀ ♀ | 408 (382–445) | 198 (177–220) | 42 (41–45) | 31 (29–34) |

Of the 29 males, 8 exceed a total length of 440; 3 reach or exceed 450; 9 fall to or below 420, and 7 to or below 410.

Of the 17 females, 1 only exceeds 440; 5 exceed 420; 12 fall below 420, and 7 below 400.

*Portola Series.*—The Portola series presents the following averages and extremes:

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 47 ♂ ♂ | ...423 (385–461) | 217 (185–230) | 41.5 (37–45) | 31.5 (29–34) |
| 40 ♀ ♀ | ...403 (380–456) | 209 (182–230) | 40 (36–46) | 31 (29–34) |

Of the 47 males, 8 exceed a total length of 440; 6 reach or exceed 450; 4 reach or exceed 460; 27 exceed 420; 20 fall below 420; 13 fall to or below 410; and 5 fall to or below 400.

Of the 40 females, 1 only exceeds 440; 12 reach or exceed 420; 28 fall below 420; 14 fall below 400.

*Both Series.*—Of the total of 133 adults—76 males and 57 females—48 males range between 400 and 440, and 28 fall outside these limits, of which 16 exceed 440 and 12 fall below 400; 34 females range between 400 and 440, and 21 fall outside these limits, of which only 2 exceed 440 and 21 fall below 400.

**5. Peromyscus californicus** (*Gambel*).—A series of 207 specimens, about one-third from La Honda and two-thirds from Portola, consist largely of adults, with, however, many nearly full-grown young of the preceding year. The variation in color among adults is not great, as regards the dorsal aspect of the animal; the ventral surface varies from clear ashy white with a trace of fulvous over the pectoral region (sometimes very pale but rarely wholly absent) to specimens in which the whole pectoral area is not only deep tawny ochraceous, but this color is prolonged medially to the abdomen, or even the whole ventral surface is strongly washed with ochraceous, most intense along the median line. About 20 per cent. of the specimens (40 out of 207) have the tip of the tail more or less white, the amount of white varying from a slight pencil of white at the tip to a white tip varying from half an inch to an inch in extent.

As regards measurements, specimens apparently fully adult present a considerable range of variation, as shown by 20 males

and 10 females (the males outnumber the females as about 10 to 1) selected at random, as follows :

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 20 ♂ ♂ | 255 (244–270) | 137 (125–156) | 30 (28–31) | 24 (22–26) |
| 10 ♀ ♀ | 260 (245–285) | 142 (126–155) | 28.5 (27–30) | 25 (23–27) |

The females thus average slightly larger than the males.

**6. Peromyscus gilberti** *Allen.*—A series of 14 specimens (8 adults, 3 young adults, and 3 young in plumbeous coat) bear out the characters given in the original description (this Bulletin, V, 1893, p. 188). The adults all have a fulvous pectoral spot, varying in different specimens from a slight trace of fulvous to a very large and distinct spot of buffy ochraceous.

The adults measure as follows :

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 3 ♂ ♂ | 210 (201–220) | 110 (105–117) | 25 (25–26) | 22 (22–23) |
| 5 ♀ ♀ | 206 (200–215) | 108 (101–114) | 24 (23–25) | 22 (21–23) |

As before said, this species is in nearly all respects externally a miniature of *P. californicus.*

**7. Peromyscus texanus gambelii** (*Baird*).—This species is represented by 163 specimens, of which 44 were taken at La Honda, Dec. 23–31, and 119 at Portola, mostly during the last week in March. Throwing out all specimens obviously not adult, the collector's measurements of these two series present the averages and extremes given in the following table :

| | | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|---|
| La Honda, | 17 ♂ ♂ | 161 (150–177) | 71.4 (61–85) | 21.2 (20–23) | 16.8 (16–18.5) |
| " | 14 ♀ ♀ | 162 (147–181) | 70 (63–80) | 21 (19–23) | 16.7 (16–18) |
| Portola, | 26 ♂ ♂ | 165 (153–179) | 75.5 (67–85) | 20.6 (19–23) | 17.1 (15.5–19) |
| " | 22 ♀ ♀ | 163 (150–180) | 75.4 (64–86) | 20.3 (18–22) | 16.7 (15–18) |

The following will show the nature of the wide variation indicated in the above table :

| | | | | |
|---|---|---|---|---|
| Total length, | 165 mm. | or more | 18 ♂ ♂, | 11 ♀ ♀ |
| " " | 175 " | " | 5 ♂ ♂, | 3 ♀ ♀ |
| " " | 160 " | or less | 11 ♂ ♂, | 15 ♀ ♀ |
| " " | 160 " | to 170 mm | 21 ♂ ♂, | 15 ♀ ♀ |

Thus 50 per cent. of the males and 42 per cent. of the females fall between 160 and 170 mm. (both numbers inclusive) in total length, and only $1\frac{1}{16}$ per cent. of the males, and rather less than 1 per cent. of the females, exceed a total length of 175.

As regards variations in color among adults, 'young adults' are darker and more heavily washed with blackish over the dorsal area than 'old adults,' about nine-tenths of which are very uniform in coloration, while about one in ten differs markedly from the average style. The variation is mainly in two directions—(1) toward excessive pallor or grayness; (2) toward a rufescent shade, in which the dorsal area is more or less strongly suffused with cinnamon rufous, varying much in intensity in different individuals. The rufescent phase is about twice as frequent in the present series as the pallid phase. Extreme examples, considered by themselves, might prove quite misleading.

**8. Reithrodontomys longicauda** (*Baird*).—A series of 16 males and 24 females, collected at La Honda, Dec. 23–31, give the following measurements:

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 16 ♂ ♂ | 137 (125–150) | 70 (64–76) | 17.5 (17 –18) | 13.5 (12.5–15) |
| 24 ♀ ♀ | 138 (124–154) | 70 (63–80) | 17.4 (16.5–18.5) | 13 (12.5–14.5) |

About 5 per cent. of the series range in total length from 124–130 mm.; these are probably young of the preceding year; but they differ in coloration from adults only in being more varied with blackish on the dorsal area. Throwing out these 'young adults' would raise the average total length to about 140 mm.

**9. Microtus edax** (*Baird*).—A series of 8 adults (2 ♂ ♂, 6 ♀ ♀) from La Honda, Dec. 25–Jan. 2, measure as follows: Total length, 170 (161–172, one specimen 198); tail vertebræ, 47 (42–50, one specimen 58); hind foot, 21.5 (19–23); ear, 14.7 (13–17).

**10. Tamias pricei** *Allen.*[1]—A series of 45 specimens, apparently all practically adult, taken at Portola by Wilbur and Diefenbach, March 23–April 15, and consisting of about an equal number

[1] *Tamias pricei* Allen, Bull. Am. Mus. Nat. Hist., VII, 1895, p. 333.

of males and females, is remarkably uniform in coloration, there being no variation in this respect calling for remark. In measurements, throwing out a few specimens with obviously mutilated tails, the variation is shown by the following:

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| 23 ♂ ♂ | 252 (234–278) | 119 (109–130) | 37 (34–39) | 21.5 (19–23) |
| 17 ♀ ♀ | 256 (241–271) | 122.5 (113–130) | 35 (32–37) | 22 (20.5–24) |

The females thus average slightly the larger, except in respect to the hind foot, which, according to the collector's measurements, is slightly longer in the male.

**11. Mus musculus** *Linn.*—A series of 8 specimens is included in the La Honda series.

**12. Sciurus fossor** *Peale.*—One specimen, La Honda, Dec. 24.

**13. Sorex montereyensis** *Merriam.*—A series of 18 specimens (5 ♂ ♂, 13 ♀ ♀), collected at La Honda, and 15 specimens (6 ♂♂, 9 ♀♀) taken at Portola, measure as follows:

| | Total Length. | Tail Vertebræ. | Hind Foot. | Ear. |
|---|---|---|---|---|
| Portola..... 6 ♂ ♂, | 109 (102–117) | 46.3 (44–48) | 13 (12–14) | 8.3 (8–9) |
| " ..... 9 ♀ ♀, | 112 (105–120) | 49 (45–53) | 13.4 (12–14) | 7.3 (7–9) |
| La Honda..... 5 ♂ ♂, | 122 (118–127) | 48 (46–51) | 15 (14–15.5) | 7.5 (7–8) |
| " .....13 ♀ ♀, | 116 (111–125) | 48 (44–52) | 14.5 (14–15) | 7.8 (7–8) |

For some not very evident reason the Portola specimens fall considerably below the La Honda series. There is no appreciable difference in other characters.

Of the 34 Shrews taken at these localities, all but one appear to be *S. montereyensis*; the other is referable to *S. californicus*.

**14. Sorex californicus** *Merriam.*—La Honda, ♂ ad., Dec. 28, Price and Wilbur. Total length, 95; tail vertebræ, 33; hind foot, 12; ear, 6.

**15. Neürotrichus gibbsii** (*Baird*).—An adult female, collected at Portola, April 6, by J. Diefenbach, carries the range of

the species considerably farther south than is indicated by previously published records. The specimen measures: Total length, 117; tail vertebræ, 38; hind foot, 14.

**16. Scapanus townsendii** (*Bachman*).—A single specimen is contained in the collection from Portola.

# Article XVIII. — NOTES ON BIRDS OBSERVED IN YUCATAN.

By Frank M. Chapman.

Our knowledge of the bird-life of the peninsula of Yucatan is more complete than the literature relating specially to the subject would lead one to suppose. A bibliography of the papers on Yucatan ornithology contains few titles, but a catalogue of the existing collections of Yucatan birds would enumerate many thousand specimens.

By far the largest number of these have been collected by Dr. George F. Gaumer, formerly of Kansas, and now a practicing physician in Izamal, Yucatan, who, for the past eighteen years, has been a persistent and successful collector of the Yucatan flora and fauna.

During the early part of this period Dr. Gaumer's birds were secured by the commercial naturalist, Adolphe Boucard, of Paris; later his collections were disposed of to Messrs. Salvin and Godman. These naturalists also obtained the major portion of the specimens collected for Boucard. With the exception of a paper in the 'Proceedings' of the Zoölogical Society, and one or two minor publications, Dr. Gaumer's collections from the peninsula have never been separately reported upon. They have, however, been incorporated in the 'Biologia Centrali-Americana,' to which work the student of Yucatan birds must refer.

The fact that Dr. Gaumer travelled extensively over the peninsula, in connection with the uniform character of the ground, renders it extremely probable that the list of Yucatan birds, at least of the permanent and summer resident species, is complete. Future work in this region, therefore, should increase our knowledge of the habits, local distribution, and especially the migrations of Yucatan birds. As a contribution to this end I present the following observations, including a 'local list'—the first list, I believe, to be published from one locality, the value of which lies chiefly in the fact of its showing the winter avifauna of a restricted territory.

The peninsula of Yucatan is a geologically recent addition to the mainland, of Pliocene and Postpliocene age. In some places the formation is entirely a shell conglomerate; in others it has become a hardened limestone.

With the exception of a range of hills in its central part, the peninsula is flat. The surface is composed largely of exposed rock, which is exceedingly uneven, being pitted, seamed and carved into innumerable small pot-holes, hollows, caves and minor irregularities. In the depressions and pockets there is a scanty deposit of earth.

The northern half of Yucatan has long been deforested, and the growth is now a dense scrub of trees and saplings, averaging one and a half to three and a half inches in diameter and fifteen to thirty feet in height. The earth will not support a crop for many successive plantings, and as a result old areas are abandoned and new ones cleared so frequently that throughout the region visited by me this scrubby wood is so alike in appearance as to deceive one into believing that it constitutes the true sylva of the country. But Dr. Gaumer, to whom I am indebted for much valuable information, tells me that this condition is artificial, and that in the less populated, southern half of the peninsula, tropical forests, composed of heavy first-growth timber, exist. He also pointed out to me the remains of this forest in northern Yucatan in the shape of certain trees (sapote or sapodillo), which, because of the value of their sap, had been spared.

With one or two minor exceptions there are no surface streams in Yucatan. Water is therefore obtained from artificial or, for the most part, natural wells termed 'cenotes.' These correspond to the 'sinks' of middle Florida, but are generally larger and deeper. They seem to be supplied by subterranean streams. These cenotes are sometimes 80–100 feet in depth and 200 feet in diameter. They are circular in outline, the walls being occasionally perfectly perpendicular from top to bottom, or, when the earth has crumbled in about the edges, a sloping side is formed. The banks of cenotes of this character, through the presence of earth and moisture, support a fairly luxuriant vegetation, in strong contrast with that of the surrounding country. Naturally, large numbers of birds are attracted to these oases.

The dry and wet seasons in Yucatan are well defined, the former beginning about November and continuing until May or June. During this period rain is infrequent, and there is little or no dew. Most of the trees lose their leaves, and the woods as a whole assume a grayish brown tint with just enough of green to suggest the appearance of a fifteen-year-old second growth in the vicinity of New York City, about May 10. The fields are brown and parched, and the region seems comparatively arid and sterile. There is thus a much greater difference between the winter and summer vegetation than in those parts of the tropics where the deep rich soil holds moisture, and supports a vegetation which in turn condenses dew.

The animal life of the country is of course much affected by these conditions, and in no tropical country that I have visited has winter been so strongly suggested. This is particularly marked with the birds, and the most interesting fact developed in the study of Yucatan bird-life is the regular, bi-annual migrations of many breeding species.

Dr. Gaumer writes (P. Z. S., 1883, 436): "The birds disappeared as the dry season advanced, except a few of the common resident species, which lived about the ranchos and at the aguados, where water was to be found. On the 23d of May the first of the summer showers occurred, which was soon followed by daily showers at midday. All nature changed as if by magic; new leaves grew, and the forests were again populated with sweet songsters."

Data are lacking to show how regular this movement is, and whether it is closely dependent upon the periods of rain; but the fact remains that we have in Yucatan a large number of birds who migrate to and from their breeding grounds, and that in a tropical avifauna a class of summer residents has been formed through climatic influences.

Yucatan bird-life, as might be expected, has been derived from Mexico and Central America. With two exceptions, *Zenaida zenaida* and *Petrochelidon fulva*, the avifauna is without a West Indian element. The first of these birds occurs only on the coast, the second is a locally common resident. Both are birds of strong flight, and their presence in Yucatan cannot be considered

as evidence in support of the theory of a former land connection with Cuba.

The peninsularity of Yucatan, in connection with environmental conditions, has evidently resulted in the formation of some fifteen or twenty races, slightly differentiated from their Mexican or Central American derivatives. It has also apparently assisted in preserving some species whose range in Mexico or Central America is now restricted to the region bordering Yucatan. The most striking case of this kind is furnished by the Ocellated Turkey (*Agriocharis*[1] *ocellata*), which is found throughout Yucatan, and is elsewhere known only in British Honduras and Guatemala. By far the larger part of its range, therefore, is included in Yucatan. But both the geologic and natural history of Yucatan clearly show that this remarkably distinct bird could not have been evolved there, nor can we suppose that the comparatively small area it inhabits in British Honduras and Guatemala can have constituted its range prior to the formation of Yucatan. It therefore seems a fair assumption that while its continental range has been restricted, the conditions of peninsular existence have proved favorable to its increase.

This, with several similar cases, may aid us in explaining the presence in Yucatan of a number of birds which, as far as known, have no representatives in any other region. *Piranga roseigularis*, *Icterus auratus*, *Antrostomus yucatanicus*, *Melanerpes rubriventris*, with two or three others, compose this class. As with *Agriocharis ocellata*, these birds appear too distinct to have originated in Yucatan, and it seems probable that either they have become extinct in the adjoining regions, or have not as yet been discovered there.

Comparing the avifauna of Florida with that of Yucatan we find they possess several points in common. The peninsula of lower Florida is but slightly older, geologically, than Yucatan, and its bird-life has also been largely derived by immigration from the mainland to which it is attached. As in Yucatan, differentiation has resulted from peninsulation, and we have numerous races whose relationships are evident. There are also two birds, the Paroquet (*Conurus carolinensis*) and Ivory-billed Woodpecker (*Campephilus principalis*), whose ranges have become much re-

[1] New genus; see p. 288.

stricted during recent years and, with the exception of a few localities in the lower Mississippi valley, these birds are now confined to Florida. The time is not far distant when the Paroquet, at least, will exist only in southern Florida; then we shall have a case in distribution not unlike those found in Yucatan.

The relationship of the avifauna of Cozumel Island to that of Yucatan is exceedingly interesting. This island is about ten miles off the east coast of Yucatan, and is some twenty-five miles long and ten miles in width. Mr. Salvin remarks (Ibis, 1885, p. 185): "The geological formation appears to be similar to that of the adjoining coast, and consists of a porous limestone, through which all rain at once passes, so that there are no surface-streams or rivers anywhere in the district."

The exploration of Cozumel, some eleven years ago, by the naturalists of the Fish Commission, Mr. Devis, and Dr. Gaumer, resulted in the remarkable discovery of between fifteen and twenty forms peculiar to the island. As might be supposed, the larger number of these have been derived from the contiguous mainland, but one species has no close relative nearer than Panama; another is not represented, even generically, nearer than Vera Cruz, while several are representatives of genera peculiar to the West Indies.

It seems probable, therefore, that Cozumel has always been an island, and that, unlike the peninsula of Yucatan, it has received its avifauna not through direct contact with the mainland, but, because of its insulation, has been populated more or less fortuitously. Yucatan being the nearest land, has, as might be expected, contributed the largest share of Cozumel bird-life, but the fact that so great a number of birds may be restricted to a small island within sight of the mainland, shows how sedentary are many species of tropical birds. It does not follow, therefore, that proximity to Yucatan implies a fauna entirely derived from Yucatan. Islands are not populated by immigration, but by the more or less accidental occurrence in them of waifs and strays, generally from the surrounding regions, but sometimes from distant regions. In this way I would account for the Vera Cruz, West Indian, and Panama elements in the Cozumel fauna.

## A List of Birds Observed at Chichen-Itza, Yucatan, from March 3 to 21, 1896.

Chichen-Itza is situated in north-central Yucatan. To reach it one takes the train from Progreso to Izamal *via* Merida. At Izamal a *volan coché* is procured for the journey of thirty-five miles to Oitas, from which place horses and mules convey one to Chichen, distant twelve miles.

Chichen-Itza, famous for its impressive Maya edifices, is now the property of Mr. Edward H. Thompson, formerly American Consul at Merida, and well known for his archæological explorations in Yucatan. It was through Mr. Thompson's courtesy and the hospitality of his *mayordomo*, Don Santiago Bolio, that I was privileged to visit Chichen, and I desire to express here my thorough appreciation of the favors I received at the hands of these gentlemen.

In Izamal it was my fortune to be the guest of Dr. and Mrs. Gaumer, and I would thank the latter for her cordial hospitality as warmly as I do the former for his kindness in supplying me with much valuable information and practical assistance.

As a matter of convenience, the classification of the 'Biologia Centrali-Americana' has been followed.

**1. Polioptila cærulea** (*Linn.*). Blue-gray Gnatcatcher. —One to three were seen almost daily. No songs were heard.

**2. Thryothorus albinucha** (*Cabot*). Cabot's Wren.— A very common bird, resembling in its notes and actions *Thryothorus ludovicianus*.

**3. Thryothorus maculipectus canobrunneus** *Ridgw.* Temax Wren.—Not quite so common as *T. albinucha*. The two birds resemble each other in their actions and choice of haunts, but differ markedly in notes, and evidently represent two different branches of their genus. The notes of *T. albinucha*, as before stated, agree with those of the more northern

*T. ludovicianus*, while the notes of *T. m. canobrunneus* are very much like those of the more southern *T. hyperythrus*.

**4. Hemiura brevicauda** (*Lawr.*). YUCATAN HOUSE WREN.—Common and occasionally heard singing, the song closely resembling that of *Troglodytes aëdon*. Two birds of this species were found occupying a nest which, with little doubt, was that of *Rhynchocyclus cinereiceps*. The latter bird was not observed, and is evidently only a summer resident at Chichen. The known nests, however, of birds of this genus, are too characteristic to be mistaken. The nest of this species, discovered by Mr. C. C. Nutting, has been described by Mr. Ridgway,[1] and I have found several similar nests of *R. sulphurescens* in Trinidad.[2] The Wrens had relined their home with fine dry grasses, and after seeing them use it daily for over a week, I naturally supposed that they were nesting. But the ease with which one may reach a false conclusion was well illustrated when on the capture and dissection of these two Wrens they both proved to be females !

**5. Mniotilta varia** (*Linn.*). BLACK-AND-WHITE WARBLER.—Three were seen.

**6. Dendroica virens** (*Gmel.*). BLACK-THROATED GREEN WARBLER.—A female, taken March 12, was acquiring two lesser coverts in the left wing, but shows no other signs of molt in progress.

**7. Seiurus aurocapillus** (*Linn.*). OVEN-BIRD.—Seen on eight occasions.

**8. Geothlypis trichas** (*Linn.*). MARYLAND YELLOW-THROAT.—Two or three were seen daily. No notes were heard beyond the characteristic *chit*.

**9. Icteria virens** (*Linn.*). YELLOW-BREASTED CHAT.—Three Chats were seen, one of which was positively identified as *virens*.

[1] Proc. U. S. Nat. Mus., V, 1882, p. 395.
[2] Bull. Am. Mus. Nat. Hist., VI, 1894, p. 39.

**10. Granatellus sallæi boucardi** *Ridgw.* BOUCARD'S WARBLER.—A female (?) taken March 2, was the only bird of this species observed.

**11. Sylvania mitrata** (*Gmel.*). HOODED WARBLER.—Nine individuals were seen. A female, taken March 17, has no black on the throat or breast and only a faint indication of this color along the upper border of the yellow parts of the forehead and cheeks. A second female, taken March 18, has a throat patch of the usual size, composed of feathers which are mottled yellow and black. The feathers of the crown and those bordering the auriculars are black tipped with olive green. Neither specimen shows signs of a molt in progress.

**12. Setophaga ruticilla** (*Linn.*). REDSTART.—Seven individuals were observed.

**13. Vireo flavifrons** *Vieill.* YELLOW-THROATED VIREO.—Two singing birds were noted.

**14. Vireo noveboracensis** (*Gm.*). WHITE-EYED VIREO.—One or two were seen daily. Occasionally they were heard calling, and on March 2 a song was heard.

**15. Vireo ochraceus** *Salv.* OCHRACEUS VIREO.—Very common. Like the White-eyed Vireo, this bird frequents undergrowth. In notes, however, there is no resemblance between the two species.

**16. Cyclorhis flaviventris yucatanensis** *Ridw.* YUCATAN CYCLORHIS.—Tolerably common. Its call resembles that of the Trinidad *C. flavipectus*, but seemed to me to possess one more note.

**17. Stelgidopteryx serripennis** (*Aud.*). ROUGH-WINGED SWALLOW.—Abundant. It roosted in holes and crevices of the ruins, appearing early in the morning, and again just before sunset.

**18. Euphonia hirundinacea** *Bonap.* BONAPARTE'S EUPHONIA.—A male of this species, taken March 18, was singing an exceedingly sweet and varied song, which was possessed of sufficient volume to be heard at a considerable distance. It was continuous, and included imitations of the notes of several birds, among others those of the White-eyed Vireo.

**19. Piranga roseigularis** *Cabot.* ROSE-THROATED TANAGER.—Not uncommon a mile or more from the hacienda, in the larger wooded growths, where it frequented the tops of the trees. All the males observed—and I have heard eight in a morning—were in song, but dissection showed little or no evidence of the approach of the breeding season. The song of this species is attractive and musical. It bears some resemblance to that of the Rose-breasted Grosbeak, but is shorter and not so loud. The song of an immature male was noticeably different from that of the adult. This bird, taken March 4, is indistinguishable from an adult female in color, evidently proving that at least two years are required for the acquisition of the full plumage.

**20. Phœnicothraupis rubicoides** (*Lafr.*). ROSE TANAGER.—Not common. Found in the woods, generally near the ground. It is a rather shy, excitable bird, and, on being alarmed, utters a harsh, scolding, Wren-like note.

**21. Saltator atriceps** (*Less.*). BLACK-HEADED TANAGER.—Common about the borders of clearings, and sometimes seen feeding on the ground in neighboring pasture-lots. It is an active, rather suspicious bird, with a painfully sharp, steely alarm-note.

**22. Cardinalis cardinalis yucatanicus** *Ridw.* YUCATAN CARDINAL.—Common. In notes and habits this subspecies resembles *C. cardinalis*, but its brighter coloration is evident even at a distance.

**23. Passerina ciris** (*Linn.*). PAINTED BUNTING.—Seven individuals were observed. A male, taken March 5, is in the plumage of the female, but has several blue feathers on either side of the head.

**24. Arremonops rufivirgata striaticeps** *Ridgw.* STRIPED-CROWNED SPARROW.—Abundant. Sometimes as many as fifty were seen in a morning. They are quite generally distributed in the undergrowth about the borders of clearings, where they pass much of their time on the ground. March 13 they began to sing, and within a few days they were singing in numbers. The song suggests that of the Field Sparrow, but is a much humbler effort.

**25. Amblycercus holosericeus** (*Licht.*). WEDGE-BILLED BLACKBIRD.—Tolerably common in and about the borders of the cornfields, where its loud, mellow whistle was occasionally heard. It is a bird of singular habits, suggesting both an Oriole and a Woodpecker. It hunts along limbs as patiently as a Creeper, tapping here and there or pounding vigorously in its efforts to secure food from cracks and crevices. In short flights it presents a laughable appearance. It progresses by jerky wing-beats, and at the end of each stroke the tail is thrown forward over the head.

**26. Callothrus robustus** (*Cab.*). RED-EYED COWBIRD.—Common about the corral and in the cornfields. A flock of about twenty birds visited the hacienda corral daily. At midday they retired to roost in a row on a stone fence beneath the shade of a thatched roof, but at other times they were walking actively about feeding. Occasionally one would rush up to another with a series of bouncing hops, but just as a collision seemed inevitable, the bird would stop and point its bill to the zenith in a most ludicrous manner. Occasionally, without apparent cause, they would all take wing, arising as one bird, and then, after a short flight over the corral, return to the ground where, after a moment's perfect stillness, they resumed feeding. The bright red eye of the adult birds gives them a peculiar, glaring expression. Immature birds have the iris brownish yellow.

**27. Icterus giraudi** *Cass.* GIRAUD'S ORIOLE.—Orioles of three species were numerous in certain blossoming trees, and were also found feeding among the weedy growth in old clear-

ings. They were shy, active and musical, whistling their call-notes and parts of songs as they passed from place to place. The present species and *I. auratus* seemed to be equally common, while *I. gularis* was more numerous.

**28. Icterus auratus** *Bonap.* GOLDEN ORIOLE.—Apparently about as common as the preceding species, though their resemblance in color to one unfamiliar with them renders field identification rather uncertain. I secured two specimens of each species.

**29. Icterus gularis** (*Wagl.*). BLACK-BACKED ORIOLE.—More common than either of the preceding species, with which it was often found associated.

**30. Dives dives** (*Licht.*). PUEBLO BLACKBIRD.—This I found to be the most characteristic bird of Yucatan towns, where it is far more abundant than in the country. Their loud, rather musical, whistling calls, are among the first sounds to be heard in the early morning, as the birds, perched in the topmost branches of the higher trees, respond to one another's challenge or salute.

**31. Xanthoura guatemalensis** *Bon.* GUATEMALA GREEN JAY.

*Xanthoura cyanocapilla* AUCT. *nec* CAB.
*Xanthoura luxuosa* SALV. & GODM. Biol. Cent. Am. Aves, I, 502 (in part).
*Xanthoura guatemalensis* BON. Consp. Av. I, 1850, 380.

Not uncommon about the borders of clearings and in the cornfields. Its notes recall the *jay, jay* of *Cyanocitta cristata*, but are not so loud and are less often uttered.

In a series containing forty specimens of this species and the Mexican *luxuosa* I find no indication of intergradation. Eight specimens of *luxuosa* from Tehuantepec closely agree with twenty from the lower Rio Grande, and differ markedly from the yellow-bellied *guatemalensis*, of which I have seven specimens from Yucatan and two from Guatemala.

Cabanis's name *cyanocapilla* (Fauna Peruana, II, 233) has generally been applied to the Central American and Yucatan birds. Cabanis evidently described a specimen from Jalapa, which, both

from his description ("Die Unterseite ist stark hellgrün angeflogen") and the locality (there is a specimen of *luxuosa* from Jalapa in the Museum), was evidently *luxuosa*, of which the name *cyanocapilla* is apparently a pure synonym.

**32. Psilorhinus mexicanus** (*Wagl.*). Brown Jay.—Rather uncommon. It was found in pairs and trios in the woods, and was rather shy and suspicious. Its call-note resembles the Blue Jay's (*Cyanocitta cristata*) imitation of a Red-shouldered Hawk's scream, but is louder and harsher.

**33. Cissolopha yucatanica** (*Du Bois*). Yucatan Blue Jay.—This was the most abundant bird observed. It was generally found in small flocks of six to twelve individuals, which seemed to have their headquarters in certain parts of the woods where they could always be found. They were especially numerous in old cornfields, forty or fifty being seen daily scattered about one cornfield near the hacienda. An intruder on their preserves is at once greeted by a chorus of harsh cries and a variety of quite indescribable calls. The birds in the immediate vicinity of the hacienda were comparatively wary, but those seen in the depths of the woods were surprisingly tame. Their curiosity was evidently much aroused by my appearance, and perching within six or eight yards, they would lean down and inspect me in an almost human way, all the time uttering their peculiar notes.

Current descriptions of this bird, including that in the 'Biologia,' ascribe the differences shown by certain individuals in the color of the bill and tail to sex, the male being stated to have a black bill and tail, while the female is said to have the bill yellow and the tail tipped with white. My series of twelve specimens shows that this variation is not sexual, but is evidently due to age. Thus I have males and females with black bills and tails, and also examples of both sexes in which the bill is yellow and the tail tipped with white. The series also contains intermediates between the two extremes.

How long a time is required for the acquisition of the adult plumage remains to be determined. Apparently at least two years, for each group of Jays had several yellow-billed individuals, about one in every four birds giving evidence of immaturity.

**34. Myiozetetes texensis** (*Giraud*). GIRAUD'S FLYCATCHER.—Observed on seven occasions.

**35. Megarhynchus pitangua** (*Linn.*). LARGE-BILLED TYRANT.—Not uncommon.

**36. Empidonax minimus** *Baird.* LEAST FLYCATCHER.—Not uncommon. No call-note was heard.

**37. Contopus brachytarsus** (*Scl.*). SHORT-LEGGED PEWEE.—Tolerably common. Its note is a low, rolling or trilled twitter, entirely unlike that of *Contopus virens*, which this species so much resembles in color.

**38. Myiarchus cinerascens** (*Lawr.*). ASH-THROATED FLYCATCHER.—Two of the three birds seen were secured. The call of a male resembled in form that of *M. crinitus*, but differed sufficiently to be at once distinguished as belonging to another species.

**39. Myiarchus yucatanensis** *Lawr.* YUCATAN FLYCATCHER.—Common. Its call-note is a complaining, whistled *whirt*, which is sometimes followed by a rather rapid musical roll. Three males, taken March 18 and 20, had the testes much enlarged, and the breeding season was evidently near at hand.

Comparison of my six specimens with Mr. Lawrence's type of *yucatanensis* from Merida, prove them to be typical of that species. Further comparison with twenty April to June specimens of *M. lawrencei* from Tamaulipas and Nuevo Leon in Mr. Sennett's collection, show well-marked differences between these two birds. As before pointed out by several writers, *lawrencei* has a slightly broader and decidedly more depressed, flatter bill, but there is also a readily apparent difference in color. This is best shown in the crown, which approaches clove brown (*cf.* Ridgway's Nomenclature of Colors) in *lawrencei* but is redder and nearer prouts brown in *yucatanensis*. In the latter, also, the back is less greenish and the belly averages paler, but this is apparent only upon comparing a series. In size, *yucatanensis* averages slightly the smaller.

**40. Tyrannus melancholicus** *Vieill.* MEXICAN KINGBIRD.—A male, taken March 20, was the only one observed.

**41. Tityra personata** *Jardine & Selby.* MEXICAN TITYRA.—Three of four specimens, observed on March 20 and 21, were secured. The testes of two males were much enlarged, while the ovaries of a female were slightly developed.

**42. Dendrocincla anabatina** *Scl.* WOOD-HEWER.—A male was taken March 17.

**43. Dendrocincla homochroa** (*Scl.*). WOOD-HEWER.—A male was taken March 14.

**44. Dendrornis flavigastra** *Sw.* WOOD-HEWER.—Tolerably common.

**45. Thamnophilus doliatus mexicanus** *Allen.* MEXICAN ANT-THRUSH.—Not common. Its song, while differing from that of *T. doliatus* in Trinidad, is nevertheless sufficiently like it to show the relationship between the two birds.

**46. Chlorostilbon caniveti** (*Less.*). CANIVET'S HUMMINGBIRD.—Not uncommon. A female taken March 4 had much enlarged ovaries.

**47. Lampornis prevosti** (*Less.*). PREVOST'S HUMMINGBIRD.—A female taken March 12 had slightly enlarged ovaries.

**48. Amazilia cinnamomea** (*Less.*). CINNAMON HUMMINGBIRD.—A male, taken March 13, had much enlarged testes.

**49. Amazilia yucatanensis** (*Cabot*). CABOT'S HUMMINGBIRD.—A female taken March 18 had much enlarged ovaries.

The condition of the sexual organs in the four species just mentioned renders it evident that with Hummingbirds the breeding season was at hand.

**50. Nyctidromus albicollis merrilli** *Senn.* MERRILL'S PARAUQUE.—Common, its call of *ker-wèe-you*, being heard each night and early morning. I was surprised to learn how rapidly these birds can run. On one occasion two lit within a few feet of me when it was light enough to distinguish their movements. They crouched close to the earth, sometimes running quickly and with unexpected ease for a few steps, then turned their heads sharply from side to side as though looking for insects. They would also spring suddenly fifteen feet into the air to catch a passing insect.

Three males from Yucatan, including one taken in June, on comparison with a series of twenty specimens of *merrilli* from Texas, are obviously to be referred to this form.

**51. Melanerpes rubriventris** (*Sw.*). SWAINSON'S WOODPECKER.—Tolerably common.

**52. Melanerpes dubius** (*Cabot*). UXMAL WOODPECKER.—Common.

**53. Dryobates scalaris parvus** *Ridgw.* CABOT'S WOODPECKER.—The few individuals observed of this species were exceedingly shy. Their call-note is a sharp *peek* resembling that of *Dryobates pubescens*.

**54. Ceophlœus scapularis** (*Vig.*). DELATTRE'S WOODPECKER.—Not uncommon.

**55. Eumomota superciliaris** (*Sw.*). RED-BACKED MOTMOT.—About ten individuals were observed. Its note is well described by Dr. Gaumer as *tah*.

**56. Crotophaga sulcirostris** (*Sw.*). GROOVE-BILLED ANI.—Common about the pastures, where it was often seen picking ticks from the cattle. It seems less sociable than *C. ani*, and single birds were often observed; whereas, in my experience, it is unusual to find an individual of *C. ani* alone. Its note is a prolonged *chee-wyyah*, easily distinguishable from the single whining whistle of *C. ani*.

**57. Amazona albifrons** (*Sparrm.*). WHITE-FRONTED PARROT.—Not uncommon, from two to five birds generally being associated.

**58. Conurus aztec** *Souancé.* AZTEC PAROQUET.—Common in small flocks of from two or three to twenty individuals.

**59. Glaucidium phalænoides** (*Daud.*). FERRUGINOUS PIGMY OWL.—Common; resembling in notes and habits individuals of the same species observed in Trinidad.

**60. Falco rufigularis** (*Daud.*). RED-THROATED FALCON.—A pair of these birds made their headquarters at one of the cenotes. Both were adult, but one was observed bringing food to the other. Their call-note was a high, rapidly-repeated squeal, somewhat suggesting the Sparrow-Hawk's call.

**61. Falco sparverius** (*Linn.*). SPARROW-HAWK.—Six or eight individuals were observed, two of which were secured.

**62. Rupornis ruficauda** (*Scl. & Salv.*). RUFOUS-WINGED HAWK.—Not uncommon. Its note is a single sharp squeal, repeated at short intervals.

**63. Herpetotheres cachinnans** *Vieill.* CRYING HAWK.—Common. The notes of this Hawk are more human and weird in character than those of any bird I have ever heard. The first individual I observed was perched on a tree growing from the top of a Maya temple. From this lookout it mocked me with a truly maniacal laugh until I had almost reached shooting distance, when, with a loud chuckle, it flew away. I did not hear this call again, but an even more uncanny one was heard each night and morning from several birds of this species living near the ruins. This is described in my journal as resembling a call of a man in great pain, and ending in an agonized wail. It was gruesome beyond description, and finally became so unpleasant that I would gladly have turned every *Herpetotheres* within sound of the hacienda into a museum specimen.

The native name of this bird is 'Koss.' Its notes should cause it to figure prominently in Indian folk-tales.

**64. Cathartes aura** (*Linn.*). Turkey Vulture.—Three or four were seen daily.

**65. Catharista atrata** (*Bart.*). Black Vulture.—Somewhat less numerous than the Turkey Vulture.

**66. Columbigallina passerina pallescens** (*Baird*). Mexican Ground Dove.—Common.

**67. Columbigallina rufipennis** (*Bonap.*). Rufous Ground Dove.—Common, fifty or more sometimes being seen feeding together in the cornfields. March 25 a pair of these birds was nesting in an orange-tree in Dr. Gaumer's garden.

**68. Melopelia leucoptera** (*Linn.*). White-winged Dove.—Abundant. In early morning and late afternoon these birds could be found in large numbers in the old cornfields. They were also seen feeding on the seeds of certain pod-bearing trees. During the middle of the day they frequented the banks of the cenotes, which they doubtless visited for shade as well as water.

Their flight is accompanied by a loud whistling sound, louder than that produced by *Zenaidura macroura* when flying. Their call is a loud, long crowing, which may be written: *Cookeree-cookeree-coo-rec-coo*, *crow-co-er-coo*, *crow-co-er-coo*. It suggests the first efforts of a young cock.

**69. Leptotila fulviventris brachyptera** (*Salvad.*). White-fronted Dove.—Abundant. This bird's call is a short, soft *coo*. Its flight is usually noiseless, but is sometimes accompanied by a whistling sound.

**70. Columba flavirostris** *Wagl.* Red-billed Pigeon.—Not common. Its call is a fine, loud *coo—whoo-er-whoo*.

**71. Agriocharis ocellata** (*Temm.*). Ocellated Turkey.—This magnificent bird was apparently common. It was not as yet calling, and the only means I had of determining its numbers was by actual observation. The flesh of the birds is, however,

so highly prized by the Indians, who doubtless have always hunted it, that it has become one of the wariest birds I have ever collected. At the best, therefore, its capture is a difficult matter, and my ignorance of both the bird and its haunts were serious handicaps. It was not until a week after my arrival that I succeeded in shooting one of these Turkeys. During this period I made their capture my chief object, doing no general collecting near the old cornfields until I had ascertained whether Turkeys were present. As a result I saw from one to six daily.

The only note I heard was a low *pūt*, but Dr. Gaumer writes (P. Z. S., 1883, p. 461) that "during the breeding season, which is in May and June, the male makes a peculiar drumming noise, very deep and sonorous; after this he utters his peculiar song, which resembles the rapid pecking of a distant Woodpecker or the song of the great Bull Toad."

The marked differences in color and form which exist between the Ocellated Turkey and the members of *Meleagris gallopavo* group, seem to me of more than specific value.

The differences in the form and distribution of the warty excrescences of the head and neck, and in the character of the erectile appendages of the forehead,[1] the more highly graduate tail and more rounded rectrices, the absence of a beard in the male and presence of rudimentary spurs in the female are all characters which entitle *ocellata* to generic distinction, and I would suggest, therefore, that it be placed in a new genus, for which I propose the name *Agriocharis*.[2]

**72. Ortalis vetula pallidiventris** *Ridgw.* YUCATAN CHACHALACCA.—Common. Each morning at about 7 o'clock these birds were heard calling. They evidently call in pairs, one bird beginning and the other soon joining. Their voice is very loud and strongly suggests the *clanging* of a Wild Goose's *honk*, a trumpet-like tone it may derive from the elongation of the trachea. Once started, the call was taken up and repeated two

[1] These are described from fresh specimens by Dr. Gaumer (Trans. Kans. Acad. Sci., VIII, 1883, p. 60) as follows: "There are twenty-four fleshy processes arranged in two rows on the front part of the neck, and about twenty more of the same kind form two rows over the head; many smaller ones are scattered over the head. At the point of union of the bill with the head, there is a long fleshy process capable of much erection and distension. Behind this the fleshy scalp is permanently elevated so as to form a flat topped pyramid, with its greatest length from bill to occiput." (See also plate of head in P. Z. S., 1861, pl. xl.)

[2] αγριος, wild. χάρις, grace.

or three times by pair after pair, and beginning thus far off it would gradually draw nearer and then pass into the distance, not to be heard again that day.

At the time of my visit Chachalaccas were feeding on the ripening fruit of the sapote or sapodillo. This they ate while it was still attached to the twig from which it grew and also after it had fallen. They are, however, arboreal rather than terrestrial, and pass by far the greater part of their time in the trees. Here they are very active, craning their neck from side to side, raising their crest and flirting their tail. When on the wing they do not appear to advantage, and with outstretched neck flap heavily and then sail a short distance.

**73. Colinus nigrogularis** (*Gould*). YUCATAN BOB-WHITE.—Abundant; resembling in notes and habits *Colinus virginianus*. It was exceedingly interesting to hear Bob-whites so unlike our *virginianus* in appearance singing and calling in a manner so nearly like our northern species that the casual listener would appreciate no difference in the voice of the two birds, though the voice of the Yucatan bird is not so loud as that of *C. virginianus*. This observation, in connection with Lieutenant Robinson's description of the notes of *Eupsychortyx sonninii*, which he states are like those of *C. virginianus*, suggests that the calls of these birds are older than the birds themselves, and that they have been inherited from a common ancestor.

**74. Ardea herodias** *Linn.* GREAT BLUE HERON.—The only water bird observed at Chichen was a Great Blue Heron, which was seen at a cenote, March 19.

LIST OF PRINCIPAL PAPERS RELATING TO YUCATAN BIRDS.

1843. CABOT, S., JR. (?)—Memorandum for the Ornithology of Yucatan. *Incidents of Travel in Yucatan.* By John L. Stephens. Harper Brothers, New York City. Vol. II, pp. 469–476.

1845. CABOT, S., JR.—Further Account of Some of the Birds of Yucatan. *Journ. Bost. Soc. Nat. Hist.*, V, pp. 90–93, pl. xii.

1852. SCLATER, P. L.—Ornithological Observations. IX. On Birds from Yucatan described by Dr. Cabot in the Journal of the Boston Natural History Society. *Jard. Contrib. Orn.*, 1852, p. 96.

1869. LAWRENCE, G. N.—List of a Collection of Birds from Northern Yucatan. *Ann. Lyc. Nat. Hist. New York*, IX, 1869, pp. 198–210.

1881. NEHRKORN, A. — Beschreibung yucatanischer Eier. *Journ. für Orn.*, 1881, pp. 65–69.

1882. LAWRENCE, G. N.—Description of a New Species of Swift of the genus *Chætura*, with Notes on two other little-known Birds. *Ann. N. Y. Acad. Sci.*, II, 1882, pp. 245–248.

1882. LAWRENCE, G. N.—Description of two New Birds from Yucatan, of the families Columbidæ and Formicariidæ. *Ann. N. Y. Acad. Sci.*, II, 1888, pp. 287, 288.

1883. BOUCARD, A.—On a Collection of Birds from Yucatan. With Notes by Osbert Salvin. *P. Z. S.*, 1883, pp, 434–462.
Based on Dr. Gaumer's collections and observations, and by far the most important publication relating to the birds of the peninsula of Yucatan.

1883. GAUMER, G. F.—Notes on *Meleagris ocellata* Cuvier. *Trans. Kans. Acad. of Sci.*, VIII, 1883, pp. 60–62.

1883. GAUMER, G. F.—Notes on the Habits of Certain Momotidæ. *Trans. Kans. Acad. of Sci.*, VIII, 1883, pp. 63–66.

1885. LAWRENCE, G. N.—Descriptions of Supposed New Birds of the Families Tyrannidæ, Cypselidæ and Columbidæ. *Ann. N. Y. Acad. Sci.*, III, 1885, pp. 156–158.

1885. LAWRENCE, G. N.—Description of a New Species of Bird of the genus *Engyptila*, with Notes on Two Yucatan Birds. *Ann. N. Y. Acad. Sci.*, III, 1885, pp. 271–273.

1885. LAWRENCE, G. N.—Characters of Two Supposed New Species of Birds from Yucatan. *Ann. N. Y. Acad. Sci.*, III, 1885, pp. 273, 274.

1885. RIDGWAY, R.—Descriptions of Some New Species of Birds from Cozumel Island, Yucatan. *Proc. Biol. Soc. of Washington*, III, 1885, pp. 21–24.

1885. SALVIN, O.—On a Collection of Birds from the Island of Cozumel. *Ibis*, 1885, pp. 185–194, 1 pl.

1885. RIDGWAY, R.—Catalogue of a Collection of Birds made on the Island of Cozumel, Yucatan, by the Naturalists of U. S. Fish Commission Steamer 'Albatross,' Capt. Z. L. Tanner, Commander. *Proc. U. S. Nat. Mus.*, VIII, 1885, pp. 560–583.

1888–90. SALVIN, O.—A List of the Birds of the Islands of the Coast of Yucatan and Bay of Honduras. *Ibis*, 1888, pp. 241–265; 1889, pp. 359–379; 1890, pp. 84–95.

1890. STONE, W.—On Birds Collected in Yucatan and Southern Mexico. *Proc. Acad. Nat. Sci. Phila.*, 1890, pp. 201–218.

# Article XIX.—TRANSFORMATIONS OF SOME NORTH AMERICAN HAWK-MOTHS.

By William Beutenmüller.

The following notes on transformation of some Sphingidæ were made during the past summer, and nearly all the eggs were received through the kindness of Mr. Jacob Doll.

## Sphinx drupiferarum *A. & S.*

*Egg.*—Oval, longer than broad, pale whitish green, smooth. Length, 1.5 mm.; width, 1.25 mm.; height, 1 mm. Laid June 11; emerged June 16. Length of young larva, 2 mm.

*Stage I.*—Head globular, smooth. Wholly pale whitish with a faint trace of a greenish tinge and no traces of the characteristic oblique bands on each side. Caudal horn rather long, black. Under the lens the larva is regularly transversely wrinkled, and as it grows older, faint traces of a whitish subdorsal stripe appears. Length, 8 mm.; caudal horn, 2 mm. Moulted June 22.

*Stage II.*—Head finely granulated. Body pale green along the sides and whitish along the dorsal region. Along each side is a fine whitish subdorsal line and oblique stripes along the sides. Caudal horn reddish. Legs green, with black tips; thoracic feet pinkish. The subdorsal line, as the larva grows older, becomes broken and is quite indistinct. Length, 18 mm. Moulted June 27.

*Stage III.*—The body is now apple green, the caudal horn redder, and the oblique stripes more distinct—whitish in the middle, greenish at each end and carmine red in front. Body and head rather strongly granulated. In some individuals the red on the oblique stripe is absent. Length, 30 mm. Moulted July 2.

*Stage IV.*—Body green, granulated, with the oblique stripes on each side pure white, with violet in front. Thoracic feet pink, yellow at their bases. Length, 43 mm. Moulted July 6.

*Stage V.*—Head large, rugose, green, with a broad russian leather red stripe on each side. Body smooth, without granulations, pale pea green, darker at the extreme sides and beneath; the oblique stripes are broad, bright violet-

purple in front and narrowly white behind. Caudal horn russian leather red. Thoracic feet russian leather red, with their basal halves yellow. Spiracles pale orange. Abdominal legs green, extremities black and preceded by a narrow yellow ring. Mouth parts black. Length, 80–85 mm. Fully grown, July 14–17. Formed pupæ July 18 and 21.

*Pupa.*—Rather large and stout, pitchy brown, segments rugosely punctured, junctions of segments dull, exceedingly finely and regularly wrinkled. Thorax and head rugose, wing-cases slightly rugose. Tongue-case closely applied to to the chest. Length, 50–52 mm.; width, 13 mm.; tongue-case, 10 mm.

The eggs were received from Mr. J. Doll, who found them on Long Island on wild cherry (*Prunus serotina*). The young larvæ, however, would not eat the leaves of this tree, and they all died. Another lot of eggs were sent me by Mr. Doll, and they were fed and raised to maturity on a species of cultivated Japanese cherry, on which they thrived very well. Mr. Doll informs me that he was likewise unable to raise his larvæ of *drupiferarum* on *Prunus serotina*. They also feed on beach plum (*Prunus maritima*), cultivated plum and cherry, and are said to also feed on hackberry (*Celtis occidentalis*). I have found the eggs on *Prunus pennsylvanicus*. My larvæ also refused to eat the leaves of cultivated apple.

## Sphinx lucitiosa *Clem.*

*Egg.*—Globular, smooth, shining, pale green, slightly longer than broad. Length, 1.25 mm.; width, 1 mm.; height, 1 mm. Laid June 4; emerged June 9. Length of young larva, 1.5 mm.

*Stage I.*—Wholly pale yellowish white, without any marking whatever. Caudal horn black. As the larva grows older it is regularly covered with transverse rows of minute white dots, and on each side is a very narrow white subdorsal stripe. Length, 7 mm. Moulted June 15.

*Stage II.*—Head globular, with numerous fine granulations. Body granulated, pale green along the sides, whitish green along the dorsal region, and a subdorsal stripe on each side. Abdominal and thoracic feet green. Along each side are faint traces of oblique bands composed of granulations. Caudal horn black. Length, 14 mm. Moulted June 20.

*Stage III.*—Head as in the previous stage, but with a yellow stripe on each side. Body with numerous yellow granulations and a yellow subdorsal stripe running from the head to the end of the third segment. The oblique lateral

bands are yellow and very distinct. Dorsal region paler green than the sides of the body. Caudal horn brownish on top, yellowish at sides and beneath. Length, 18 mm. Moulted June 23.

*Stage IV.*—Similar to the last stage, but the caudal horn is much stouter and pale greenish with a pinkish tinge or is wholly green. The oblique lateral bands are yellow behind, whitish in the middle and pink in front. Head with a broad, bright yellow stripe on each side, and on the body is a short, yellow, subdorsal stripe on the anterior segments. Thoracic feet yellowish at base, claret red at tip. Body bright yellowish green, paler along the back. Length, 33 mm. Moulted June 29.

*Stage V.*—Head smooth, with a broad yellow stripe on each side in front. Thoracic feet yellow and tipped with red. Body bright yellowish green, entirely smooth, the granulations being reduced to yellowish dots. On the second and third segments there are many white dots encircled with black. The oblique lateral bands are finely black in front, carmine red in the middle and white behind. The white on the last band reaches to the base of the caudal horn, which is green, with a broad black stripe on each side. When fully grown the larva becomes apple green, smooth and darker on the first, second and third segments. The oblique bands lose the black on the anterior part, and they are bright carmine red in front and clear white behind. The head is somewhat rugose, apple green, with the yellow stripe on each side pale green. The thoracic feet are pale yellow at base and cherry red at their tips. Anal and abdominal legs wholly green. Spiracles pale orange. In some individuals the carmine of the lateral bands is inclined to be purplish. Length, 60 mm. Fully fed July 9, 11 and 13. Head, 5.5 mm. wide ; 5.75 mm. high.

*Pupa.*—Rather small, pitchy brown, rugosely punctured and wrinkled. Tongue-case very short, slightly curved or straight. Projection on last segment rather long and stout at base, sharply pointed at tip with two very small spines. Length, 34 mm.; width, 10 mm.; tongue-case, 3 mm.; anal projection, 4 mm.

The eggs were received from Mr. J. Doll. They were found on the leaves of willow (*Salix discolor?*), and it is possible that they will also feed on other species of willow. My larvæ were raised on Lombardy poplar.

## Sphinx kalmiæ *A. & S.*

*Egg.*—Oval, smooth, pale semitranslucent whitish green. Laid June 22. Emerged June 28, 1896. Length of young larva, 1.5 mm.

*Stage I.*—Wholly pale whitish. Caudal horn black. As it grows older the body becomes greenish and there appear faint traces of a whitish subdorsal line on each side. Length, 12 mm.

*Stage II.*—Greener than in the last stage, with a fine white subdorsal stripe and fine white oblique lateral bands. Head and body finely granulated. Caudal horn black, with short black bristles, like spines at the tip. Body along the back whitish green, somewhat darker green along the sides. Legs and feet wholly green. Length, 18 mm. Moulted July 5 and 6.

*Stage III.*—The head is now bright apple green, with a yellow stripe on each side. The body is also bright apple green at the sides and beneath; along the dorsal region, pale whitish green. Caudal horn bluish, with short black spines. The oblique bands are now blue black in front, white in the middle and yellow behind. The granulations on the anterior segments are more numerous than on the sides. Length, 22–25 mm. Moulted July 7 and 8.

*Stage IV.*—Head with a yellow or yellow and black stripe on each side. The body is now much smoother than in the preceding stage, and the oblique bands are sky blue in front, white in the middle and yellow behind, the yellow of the last band running to the base of the caudal horn, which is blue at the basal half on top, yellowish green beneath, and outer half jet black, with black spines. Thoracic feet black, white at their bases, with a narrow black ring. Abdominal and anal legs green. Anal plates with black granulations. Length, 36 mm. Moulted July 10, 11, 12 and 13.

*Stage V.*—Body now entirely smooth and without granulations, bright green, and much paler along the back than along the sides. Head rather small, with a broad jet black stripe on each side and a light yellowish green one before the black one. The oblique lateral bands are now broadly jet black, finely white along the middle and broadly canary yellow behind. Caudal horn blue, with jet black granulations. Spiracles pale orange. Thoracic feet black, with a bluish ring at their bases. Abdominal legs green inside, with a jet black band outside at the base and at the extremities, and yellowish green between. Anal plates with black granulations; extremities black. Length, when fully grown, 65 mm. Stopped feeding July 14–18. Formed pupæ July 16, 18, 19, 20 and 21. Moths emerged August 1, 3, 4, 5, 6 and 7.

*Pupa.*—Deep chestnut brown, wing-cases and thorax pitchy brown, as are also the leg-cases, which are streaked at their junction with light chestnut color. Tongue-case slightly curved, stout, about one-third the length of the wing-cases. Anal projection rather short. Length, 42 mm.; width, 11 mm.; tongue-case, 8 mm.; anal projection, 2 mm.

The eggs were obtained from a female collected at light at Greenwood Lake, New Jersey, and the larvæ were raised on lilac. They also feed on laurel, ash, privet and *Chionanthus*.

## Sphinx plebeius *Fabr.*

*Egg.*—Pale green, smooth, shining, very slightly longer than broad. Length, 1.2 mm.; width, 1 mm.; height, .75 mm. Emerged July 15. Length of young larva, 1.5 mm.

*Stage I.*—Wholly pale shining green, with a subdorsal stripe of a whitish color along each side, and a finer one along the extreme sides. Head minutely granulate. Length, 12 mm. Moulted July 19.

*Stage II.*—Head and body regularly granulated; body apple green above, bluish green at the extreme sides and underneath. The oblique lateral bands are yellowish white, and the subdorsal stripe yellow and composed of granulations from the anterior edge of the first segment to the end of the third segment. Caudal horn rather long, bluish above, greenish at the sides and beneath, and with a few blackish points. Length, 22 mm. Moulted July 21.

*Stage III.*—Body above apple green laterally, and beneath blue green, finely granulated, with the short granulated subdorsal stripe as in the last stage. The oblique lateral bands are yellowish green and whitish green as they enter the paler color on the dorsal region, and whitish in the bluish green lateral portion of the body. First three segments above and below apple green, as also are the thoracic feet. Abdominal and anal legs blue green. Caudal horn bluish with the tip green. Spiracles orange. Length, 35 mm. Moulted July 24 and 25.

*Stage IV.*—The dorsal region of the body is now bright yellowish green and the sides and underneath bluish green, standing in strong contrast to the color along the dorsal region. The oblique bands are yellow as they enter into the yellowish green color on the back, and whitish green at the sides. Caudal horn bluish lead color. Body dotted with yellow granular dots at the sides and beneath with whitish. First three segments wholly green, with a subdorsal line composed of yellow granular dots. Head globose, with greenish white granules. Spiracles cream color, black at each side. At the sides of the body behind each oblique band on the bluish green lateral parts is a triangular bluish flush. In mature larvæ the caudal horn is decidedly blue, yellowish green on top, with yellow granules. Length, 68 mm. Entered the ground to pupate July 28 and 30. Formed pupæ July 31 and Aug. 2.

*Pupa.*—Bright shining chestnut brown, finely punctured. Tongue-case long, slender, straight and closely applied to the chest. Anal projection sharp, rather short, with two minute spines at tip. Length, 40 mm.; width, 11 mm.; tongue-case, 13 mm.; anal projection, 1.5 mm.

The eggs were received from Mr. J. Doll. The larvæ were fed on trumpet vine (*Tacoma radicans*), which seems to be, as far

as we know at present, its only food-plant. They passed through only three moults, instead of four or five, as is usually the case with other Sphingid larvæ. They fed very rapidly, it taking but sixteen days to reach maturity.

## Ceratomia undulosa (*Walker*).

*Egg.*—Pale green, smooth, shining, longer than broad. Length, 1.5 mm. ; width, 1.25 mm. ; height, 1 mm. Laid June 8. Emerged June 13.

*Stage I.*—Head subtriangular. Wholly pale green, with a narrow, pale yellow subdorsal stripe along each side of the body. Caudal horn pale brown. Length, 10 mm. Moulted June 18 and 19.

*Stage II.*—Pale green ; body transversely wrinkled, with the subdorsal yellow stripe broader and more distinct than in the previous stage. Caudal horn reddish black. Head granulated, with an indistinct yellow stripe on each side. Length, 15 mm. ; caudal horn, 3 mm. Moulted June 20 and 21.

*Stage III.*—In this stage the subdorsal stripe is very conspicuous, being clear yellow and quite broad. The stripe on each side of the head is also broad and clear yellow. Along each side of the body are seven yellow, oblique bands, which become white as they reach the subdorsal stripe. In some individuals there is a row of red spots along each side, one spot on each segment, situated on the subdorsal stripe from the fourth to the tenth segment inclusive. On the stripe of the head is also a red spot. Spiracles orange. Caudal horn long and stout, reddish, with very short spines. The body color is yellowish green above and brighter green beneath. As the larvæ grow older the subdorsal stripe becomes broken by the oblique lateral bands, which are then very distinct and conspicuous. Length, 23 mm. ; caudal horn, 4 mm. Moulted June 25 and 26.

*Stage IV.*—Head subtriangular, almost smooth, with the stripe on each side broad. Anterior segments of the body with a few granulations ; sides of body pale green ; dorsal region yellowish green, with regular transverse wrinkles which are yellowish. The oblique bands are very distinct and quite broad, white at the middle, yellow at each end, and with a claret red streak on the anterior part of each ; in some specimens the red is absent, and in others there is a large carmine blotch before each oblique band, and one on the head on the yellow stripe. The last oblique stripe is very broad and does not run to the end of the caudal horn, as is the case with some species of Sphingid larvæ. Caudal horn is either rose red or pale violet with fine black granules. Length, 35 mm. Moulted June 29 and 30.

*Stage V.*—The larva is now entirely smooth, except the anal plates, which are finely granulated with black. The stripes on the head are now white instead of yellow. Body at the sides uniformly blue green, dorsal region yellowish green and transversely wrinkled. Spiracles large and conspicuous, white centrally and orange red outside. The oblique bands are conspicuously white and broad, and in some individuals reddish in front. Caudal horn pinkish. Thoracic feet pink, paler at the base. When fully grown the larvæ become grayish green along the sides and beneath, and remain yellowish green along the back. The stripes on the head become whitish flesh-color. The oblique lateral bands are whitish and yellow as they run into the reddish green color on the back. Caudal horn pinkish at the sides. Some individuals of the brood have the back very bright yellowish green ; the head lilac with the stripes decidedly flesh-color, and before each oblique band is a large ferrugineous patch. Abdominal legs outside pinkish. Fully grown July 5–6. Length, 65 mm. Entered the ground for pupation July 6–7, and formed pupa July 9–11. Moths emerged July 22–23.

*Pupa.*—Dark chestnut brown, shining, without a tongue-case ; anal projection rather short ; segments punctured ; wing-cases smooth. Length, 45 mm.

The eggs were obtained from a female collected in Hoboken, New Jersey, by Mr. W. Sachs, and the larvæ were raised on lilac. They also feed on ash and privet (*Ligustrum*), and are double brooded. Mr. Sachs informs me that one larva of the brood he raised was entirely ferrugineous.

## Smerinthus myops (*A. & S.*).

*Egg.*—Pale green, smooth, shining, longer than broad. Length, 1 mm.; width, .75 mm. Laid June 3. Emerged June 10.

*Stage I.*—Pale green, covered with short, pale sordid white hairs. Caudal horn green. Head globular and granulated. Length, 7 mm. Moulted June 15.

*Stage II.*—Head triangular with the granules larger, and along each side of the body is a short yellowish green subdorsal stripe running from the head to the end of the fourth segment ; along the sides are also oblique yellowish green bands. Legs green ; thoracic feet pink ; caudal horn red. Length, 14 mm. Moulted June 20.

*Stage III.*—Body yellowish green, head decidedly triangular and forming a tubercular process at the apex, granulations canary yellow, as are also those on the body. The short subdorsal stripe is composed of granular serrations ; lateral

oblique yellow bands distinct. Thoracic feet red. Caudal horn red with indications of the last oblique band at the sides. One specimen has a red spot on each side of the second and fifth segments. Length, 18 mm. Moulted June 24.

*Stage IV.*—Very much like the last stage, but the last oblique lateral band is clear yellow and runs to the end of the caudal horn, which is now entirely yellow. Length, 27 mm. Moulted June 28.

*Stage V.*—The body is now bright yellowish green above and below, covered with fine yellow granulations ; the last oblique band is much brighter yellow and broader than the rest, and runs to the end of the caudal horn. Head triangular with the tubercles on the vertex much reduced. Spiracles white in the centre and red outside. Length, 40 mm. Fully grown July 5.

*Pupa.*—Similar to that of *S. excæcatus* and *S. geminatus*, but much smaller and more glossy. Segments rugosely punctured and shining, junctions of segment opaque. Wing-cases smooth and very shining. Tongue-case absent. Anal projections short. Length, 25–30 mm ; width, 8–9 mm.

The eggs were received from Mr. J. Doll, and the larvæ were raised on wild cherry (*Prunus serotina*). As compared with *S. geminatus* and *excæcatus* the larva of *S. myops* differ from these by having the granulations on the body much finer, and the short subdorsal stripe on the anterior segments quite indistinct, while in *geminatus* and *excæcatus* this stripe is composed of prominent serrations. The lateral oblique bands of *myops* are also fainter.

# Article XX.—NOTICE AND DESCRIPTION OF NEW SPECIES AND A NEW GENUS OF PHYLLOCARIDÆ.

By R. P. Whitfield.

Plates XII–XIV.

Mr. Edgar E. Teller and Mr. Charles E. Monroe, of Milwaukee, Wisconsin, have placed in my hands a collection of remains of Ceratiocaris-like Crustaceans, for determination and description, which they obtained near Waubeka, Wisconsin. The quarries in which these specimens were found are situated about one mile north of the village, near the Milwaukee River, and are described in Volume II of the Geological Survey of Wisconsin, where they are referred to the Lower Helderberg formation. The remains are found in the present bed of the quarry in a layer used for building-stone and flagging, and seem to be fairly numerous, judging from the number of fragments obtained.

In studying these fossils I find among them representatives of three distinct forms. One of these, and by far the most abundant, belongs to the genus *Ceratiocaris*, so far as the general form and features are concerned, while one other differs considerably in the form of the carapace and appears to belong to a distinct genus, for which I propose the name Entomocaris, from the resemblance of the carapace to that of an ostracode entomostracan, since it is strongly curved in front and behind on the dorsal margin, instead of being nearly or quite straight, as in *Ceratiocaris*. This renders it probable that there was a hiatus between the two sides of the carapace both in front and behind. The posterior margin was not truncated as in *Ceratiocaris*, but obtusely rounded, more as in *Colpocaris* M. & W., and *Rhinocaris* Clarke, indicating a bivalved carapace.

## Entomocaris,[1] new genus.

Carapace ovate in outline, bivalvular, with a strong hiatus in front and rounded behind; hinge line straight for about half its length. Rostrum not

[1] ἔντομος, cut up; καρίς, a shrimp.

known. Abdomen composed of fourteen or more segments, three or four of which may be naked. The post-abdomen bears three spines, the central one or telson, elongate and slender, and the lateral ones (*cercopods*) flattened and articulated to the caudal plate.

## Entomocaris telleri, n. sp.

PLATE XII, FIG. 1, AND PLATE XIV, FIGS. 1, 2 AND 7.

Specimens of more than medium size, the only entire individual seen measuring about twenty-one centimeters in length by six and one-half centimeters dorso-ventrally across the carapace.

Carapace ovate in general outline, straightened on the middle portion of the dorsal margin and gibbously rounded on the ventral ; widest a little behind the middle of the length ; antero-dorsal margin rather strongly curved for three and one-half centimeters from the anterior end, which is marked by a narrow, sharp beak half a centimeter long ; on the postero-dorsal margin the border is more abruptly rounded and margined by a narrow, thickened border which extends entirely around the ventral portion to the base of the anterior beak ; surface marked by very fine, wavy striæ, much too fine and faint for representation on the figures.

Abdomen much elongated, composed of fourteen or more segments. The anterior ones within the limits of the carapace must have been quite short, but their outlines cannot be seen, and their presence and number are only shown by the indications of slender limbs (swimmerets) as seen pushing up the crust of the carapace which overlies them. Farther back the segments are more distinct. The terminal segment is long, about one-fourth longer than high. Surface of the body segments granulose, so far as can be seen by a good lens ; no other marking being visible.

Telson moderately large ; spine straight and slender, as long as the last four and a half body segments ; thickened in the middle as it lies flattened on the rock, leaving a deep median depression in the matrix where removed. Lateral spines strong and thickened on the margins, the entire length not indicated on the stone, from the breakage of the surface.

The swimmerets seem to have been slender, judging from indications left on the specimen.

Mandibles very imperfectly represented. An indication of their existence is seen in the elevation of the crust of the carapace, but with considerable uncertainty. The mandibles shown on Plate XIV, Figs. 1 and 2, have been referred with some doubt to this species, principally on account of their greater strength and the difference in form from those preserved in the specimens of *Ceratiocaris monroei*. These are somewhat triangular, and are provided with five strong cusps of much the same form as those of the species just mentioned, but the manubrium is quite different in its detail, especially in the large triangular opening in the inner surface for the passage of the muscular parts.

This species differs from *Certiocaris monroei*, with which it is associated, principally in the form of the carapace, which is rounded posteriorly instead of being obliquely truncated, and has the dorsal line rounded in front of and behind the proportionally shorter hinge line. It also differs in the absence of the peculiar surface structure of the body segments and in the form of the lateral appendages of the tail, which are provided with thickened margins in this species, whereas those of the best preserved example of that species are flattened and smooth, or at most have an impressed line of minute punctures which may represent the bases of a row of fine setæ.

## **Ceratiocaris monroei,** n. sp.

PLATE XIII, FIGS. 1–5, AND PLATE XIV, FIGS. 3–8.

Specimens of moderately large size. Carapace of semielliptical form, about three-fifths as high as long ; dorsal line very nearly straight, anterior extremity slightly beaked, posterior end obliquely truncated, longer below than above, with the truncation a little more than half the height ; ventral margin irregularly rounded, more gibbous in the middle or just anterior to the middle of its length ; margin thickened, forming a narrow flat border which extends from the rostrum in front to the posterior basal angle, which is rounded ; surface of the crust very finely and evenly striated, the striæ passing obliquely downward and forward from the dorsal line and nearly parallel to the basal margin and again upward toward the anterior end. The striæ number from twelve to fifteen in the space of one millimeter ; substance of the carapace very thin ; ocular tubercle not positively observed.

Abdomen composed of about fourteen segments, those within the carapace short and slender, enlarging backward in both length and width until their width (or height) is more than half the dorso-ventral height of the carapace ; four or more segments apparently exposed beyond the posterior margin of the carapace ; the last segment long, twice or more than twice as long as that in front, and rapidly narrowed backward to the junction with the telson.

Telson long and slender, and when flattened from the side is seen to have been slightly recurved and probably somewhat triangular in section, but evidently marked by a thickened central rib which shows convex both on the substance and in the impression of the opposite side of the same individual. It is also armed with a thin, flattened, slightly recurved, lanceolate appendage or lateral spine (*cercopod*) on each side, articulated just behind the articulation of the caudal plate, and of about half or less than half the length of the central spine. These appendages are usually destitute of any ornamentation, but in

one or two cases show a line of fine punctures near the upper margin, while the central spine shows a row of minute punctures on each side, and in some cases rows of hair-like spines.

Mandibles rather large and strong, somewhat hatchet-shaped and armed with five or six protuberances near the masticating edge. The upper or outer surface appears to have been smooth and flat. On the inner face they are thickened near the margin for the teeth, and behind these an oval opening is seen which extends to near the posterior margin, probably for the passage of the motor ligament.

Surface of the abdominal rings marked by wavy lines toward the sides and below, and above the median line passing into a peculiar tessellated structure composed of zigzag lines and punctures.

Several of the specimens showing the abdominal segments retain portions of the swimming feet or imprints of them. None of them, however, are sufficiently well preserved to show an entire limb satisfactorily. There appears to have been one pair to each segment, and the limbs seem to have decreased slightly in length and thickness from the larger segments backward, and much more rapidly from the same point forward, as seen on several specimens. These limbs (*swimmerets*) appear to be composed of the three outer joints only, those nearer the body not being distinguishable. The outer joint seems to be flattened, and in one or more specimens appears to have been margined with fine setæ.

On two of the abdomens preserved, there is seen an impression running along the central line and extending from near the anterior end of the body backward, terminating just in front of the telson near the ventral margin. This I presume to have been the intestinal canal. In one of the specimens it is deeply and strongly marked, and appears as if it had been undulated by numerous constrictions; in another it looks as if transversely corrugated. If it is the imprint of the intestinal canal, it was probably distended with food when the animal died, since the impression left is quite strong.

This species differs from *C. maccoyana* and *C. aculeata* Hall, from the Water-lime formation of New York (Pal. N. Y., Vol. III, pp. 421*, 422*, Pl. 84, Figs. 1–6) in the shorter form of the carapace and in the entirely different proportions of the spines of the tail, the *cercopods* in that species being very nearly as long as the telson, while in this one they are only about half as long.

## **Ceratiocaris poduriformis,** n. sp.

PLATE XIV, FIG. 10.

Carapace unknown. Abdomen very small, sublinear and elongate-cylindrical; segments, of which only four are known, proportionally long and narrow, the

last one rather more than twice as long as thick, and very slightly tapering ; the second one as long as high, and the two in front higher than long ; articulating margins oblique.

Telson as long as two and a half of the body segments, counting from behind ; central spine slender and its appendages about half its length.

Surface, as seen on some of the crust preserved in the matrix, marked by slightly oblique, somewhat wavy striæ.

This specimen appeared so doubtful at first that I scarcely considered it as belonging to the genus, but on further examination I thought it might be an articulated rostrum of one of the species, if they really were provided with such an appendage. With this idea in mind I placed the specimen under a higher magnifying power to examine the crust, which is partly preserved in the matrix, when I found that there was a caudal appendage, mostly covered by adhering rock. This I subsequently uncovered to its entire length, revealing the articulated appendages and proving the specimen to be in fact a small *Ceratiocaris*. It can hardly be the young of either of the species with which it is associated, on account of the difference in the proportion of the length and height of the segments, and I have considered it a distinct species, as was originally suggested to me by Mr. Teller, the discoverer. The specific name applied will recall its resemblance to *Podura*, the 'skip-jack' or 'spring-tail.'

*General Remarks.*—The specimens of Phyllocaridæ found in the quarries mentioned at the beginning of this article are quite numerous, but consist mostly of the caudal spines and mandibles. A few imperfect bodies have been obtained, and also a few preserving more or less of the carapace. A single almost entire individual of *Entomocaris telleri* was obtained and is figured on Plate XII. It is also probable that some of the caudal spines and some of the mandibles found belong to that species, but it is quite impossible at the present time to decide with any degree of certainty to which of these species any of the detached fragments may have belonged. Among the mandibles there appear to be two quite different forms, one having a small oval or rounded opening on the under or inner surface, and the other presenting a much larger, subtriangular opening. The latter form is usually the larger and stronger, hence I have inferred that it may belong

to *E. telleri*, since the smaller, hatchet-shaped mandible with the round or oval foramen is often found connected with the examples of the carapaces of *C. monroei*.

The same difficulty arises in trying to determine to which of the species the detached caudal spines belong. The articulated appendages of the telson of *Entomocaris telleri*, however, have a thickened margin, while those found actually attached to the other species have not. This feature will be found something of a guide in placing them. Of the third species, *Ceratiocaris poduriformis*, there has been found only one specimen, that figured, and its counterpart, and it is probably a rare form.

Much credit is due to Mr. Teller and to Mr. Monroe for their care in collecting the many fragments of these obscure forms; and also for their great liberality in presenting to the American Museum of Natural History all the type specimens figured in this paper.

# Article XXI.—THE CHAZY OF LAKE CHAMPLAIN.

By Ezra Brainerd and Henry M. Seely.

We present in this article an account of three exposures of the Chazy formation along the shores of Lake Champlain. For the collecting of fossils and for detailed measurements these outcrops are more favorable than at Chazy[1] village, where the formation was first studied by Professors Emmons and Hall. The rocky shores of islands and promontories in the lake region are cleared of soil by the waves, the lake level is a convenient datum for measurements, and government charts furnish accurate outlines for mapping.

## The Valcour Island Section.

By far the best exhibit of the Chazy formation is at Valcour Island and on the neighboring mainland, from Bluff Point to Port Jackson. It here attains its maximum thickness. The base of the formation is seen resting upon the yellow magnesian limestone at the top of the Calciferous, and may be traced upward in various exposures through 890 feet of strata, till its summit is seen underlying the Black River limestone.

The strata here measured are as follows, in ascending order :

### *Group A (Lower Chazy).*

1. Gray or drab-colored sandstone, interstratified with thin (or sometimes thick) layers of slate, and with occasional thin layers of limestone at the base, containing *Camerella* (?) *costata* Bill ..... .....56 feet.

The slaty sandstone gradually passes into

2. Massive beds, made up of thin alternating layers of tough slate and of nodular limestone, containing undetermined species of *Orthis* and *Orthoceras*..... ..... ....82 "

---

[1] See paper, 'The Original Chazy Rocks,' American Geologist, Nov., 1888, Vol. II, p. 323.

3. Dark bluish-gray, somewhat impure limestone, in beds of variable thickness ; often packed with *Orthis costalis* Hall, which occurs with more or less frequency through the whole mass. Other fossils are : *Lingula huronensis* Bill., *Harpes antiquatus* Bill., *Harpes ottawaënsis* Bill. (?), *Illænus arcturus* Hall (*I. bayfieldii* Bill.), *Lituites*, sp. (?).....110 feet.

4. Gray, tolerably pure limestone in beds 8 to 20 inches thick, separated by earthy seams, the bedding being uneven. Many layers consist of crinoidal fragments, largely of *Palæocystites tenuiradiatus* Hall. Near the middle of the mass, for a thickness of 10 feet, some of the fragments and small ovoid masses (*Bolboporites americanus* Bill.) are of a bright red color.....90 "

Making for the total thickness of *A* .....338 feet.

## *Group B (Middle Chazy).*

1. Impure, nodular limestone, containing *Maclurea magna* Leseuer....25 feet.

2. Gray, massive, pure limestone, abounding in crinoidal fragments....20 "

3. Bluish-black, thick-bedded limestone usually weathering so as to show pure nodular masses enveloped in a somewhat impure, lighter-colored matrix ; everywhere characterized by *Maclurea magna.* Near the middle of this mass, for a thickness of about 30 feet, the fossils are silicified and of jet-black color. The more important, besides *Maclurea*, are species of *Strophomena*, *Orthis* and *Orthoceras*.....210 "

4. Dark, compact, fine-grained limestone, with obscure bedding, weathering to a light gray. Fossils are infrequent, but at a single locality there were collected *Orthis perveta* Con., *Orthis platys* Bill., *Leptæna fasciata* Hall, *Asaphus canalis* Con., *Cheirurus polydorus* Bill., *Harpes*, sp. und., *Illænus incertus* Bill., *Lichas minganensis* Bill., *Sphærexochus parvus* Bill., and several undescribed species..20 "

5. Bluish-black limestone like number 3, but less pure, containing *Maclurea magna* Leseuer, *Orthis perveta* Con., *Strophomena incrassata* Hall, *Orthis disparilis* Con., or *O. porcia* Bill .....75 "

Total thickness of *B*.....350 feet.

## *Group C (Upper Chazy).*

1. Dove-colored compact limestone, in massive beds, containing a large species of *Orthoceras* ; *Placoparia* (*Calymene*) *multicostata* Hall, *Solenopora compacta* ; and a large *Bucania* .....60 feet.

2. Dark impure limestone, in thin beds, abounding in *Rhynchonella plena* ; at the base a bed 4 or 5 feet thick is filled with various forms of *Monticulipora* or *Stenopora* .....125 "

3. Tough, arenaceous magnesian limestone, passing into fine-grained sandstone..... 17 "

Total thickness of *C*.....202 feet.

Aggregate thickness of the Chazy on Valcour Island.....890 feet.

Valcour Island, which lies about six miles south of Plattsburgh, N. Y., is over two miles in length and one mile in width. Almost the entire shore is rocky, with deep bays and steep promontories, sometimes fifty feet in height. The strata slope for the most part eastward at an angle of from 3° to 7°; but a little north of the centre of the island there is a shallow syncline. Along the northwest shore of Sloop Cove is a minor fault, extending across the promontory north of the Cove. The excavation of the bay is doubtless due to this fault. Across the northern end of the island runs a greater fault, with an upthrow on the south side. The strata north of the fault dip to the northeast, the highest rock on the northeast point being the Black River limestone. Underneath, as we go westward, are seen the strata of *Group C*, Chazy, and the upper part of *Group B*.

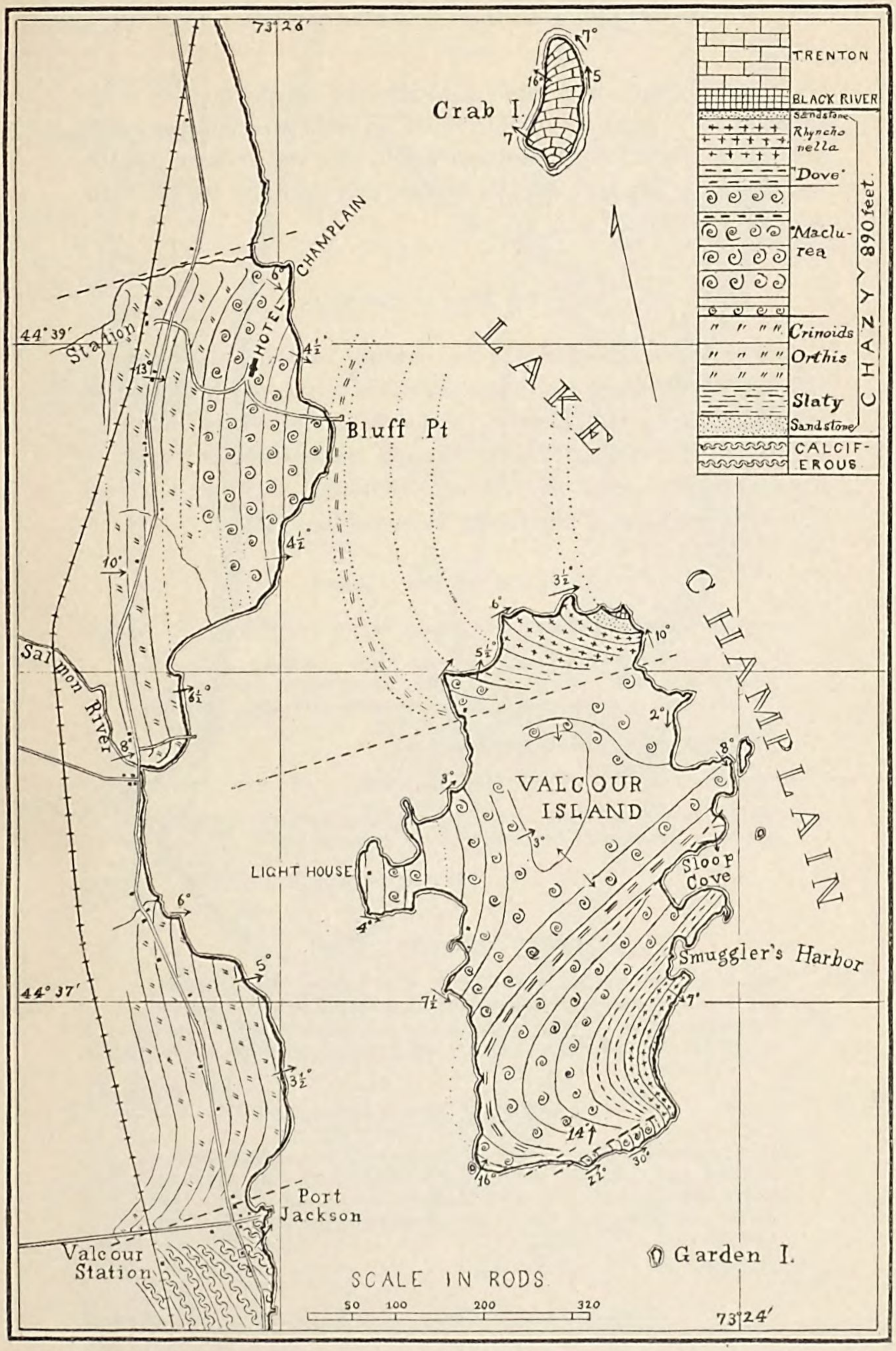
At the south end of the island there is evidence of still greater disturbance. A fault with two branches runs in from the south shore to the northeast, but does not extend to the east shore. The rocks at the southeast are thus tilted to the east at an angle of from 22° to 30°, exposing the sandstone at the very base of the formation. The thickness of Chazy strata seen here is over 600 feet—in fact, the whole of the formation is exposed except the upper 80 feet and about 200 feet covered with soil. This hiatus of the upper part of *Group A* seems to have been caused by the removal by glacial action of the narrow mass of rock between the fault and the shore line. About one hundred rods southeast is a small rocky island, called Garden Island, consisting of the slaty strata of *Group A*, and lying in the strike of the same strata on Valcour Island.

If we turn our attention now to the mainland, we shall find the Chazy rock extending for three miles along the shore to the west of Valcour Island. It is terminated on the north by a transverse fault with an uplift on the south, as is indicated by a sudden westward curvature of the strike of the Chazy. North of this fault is a sand plain extending to the village of Plattsburgh. On the south also the Chazy uplift is terminated by a fault (another branch of the fault seen on the south side of Valcour Island), bringing up here the strata of the Calciferous. It is a noteworthy fact that all these principal faults, like those observed at Ticon-

deroga and elsewhere along the lake, consist of uplifts of the strata nearest to the neighboring Archean terrane. It is only four miles from Port Jackson south to the well-known display of Potsdam sandstone at the Ausable Chasm, and only six miles south to the Archean of Trembleau Point.

The strike of this outcrop of Chazy is quite uniformly north and south, with an eastern dip increasing as we go westward from 3° to 12°. It consists of the lower strata of the Chazy, though the sandstone at the base of the formation is not disclosed. The lowest rock seen is the slaty limestone (A, 2), well exposed in the bed of the Salmon River near its mouth. The remaining strata of *Group A* are displayed in long ledges lying on either side of the highway between Port Jackson and Plattsburgh. Especially favorable for the collecting of fossils are the old quarries and the broad fringe of sloping rocks along the shore for a mile north of Port Jackson. About fifty rods south of the Bluff Point Railway station are extensive quarries in the crinoidal beds of No. 5, A, from which a beautiful red-spotted marble is manufactured. As we go eastward from the station to the Hotel Champlain we pass rapidly over the lower Maclurea beds, till we reach the summit of the ridge on which the hotel is situated, 180 feet above the lake. The eastward slope, south of the driveway to the wharf, is with the strata, which here consist of the massive beds of No. 4, B, broken at the shore-line so as to form high cliffs. It is highly probable that the higher strata continue eastward under the waters of the lake, and are connected without a break with the exposures of the Upper Chazy at the north end of Valcour Island. We may also infer that the outcrop north of Port Jackson is continuous under the lake with the outcrop on the Light House promontory and the main body of Valcour Island. For the dip and strike on both sides of the channel are similar, and the strata here lacking have a thickness elsewhere which would nearly fill the gap between the island and the mainland.

Before closing our account of this interesting region, we would call attention to the fine outcrop of Trenton limestone at Crab Island, about a mile northeast of Bluff Point. The island is only 145 rods in length, but discloses over 200 feet of strata. As will




VALCOUR IS. AND BLUFF PT., N. Y.

be seen from the strike and dip indicated on the map, it is the remnant of a sharp anticline with an axis descending north-northeast. Strata in this attitude would offer the greatest possible resistance to glacial action, and this may account for the existence of the island.

## Isle La Motte Section.

Our second map represents the outcrop of Chazy limestone at Isle La Motte, which lies about 14 miles to the north of Valcour Island. The strata appear on the south half of the island with a somewhat sinuous strike and dipping northward at an angle of from 3° to 5°. After 60 feet of Calciferous rock we have the following measures of the Chazy in ascending order :

### *Group A (Lower Chazy).*

1. Layers of sandstone and slate containing *Lingula* and *Orthis*..... 23 feet.
2. Silicious limestone with seams of tough slate containing *Camerella breviplicata* Bill., *Orthis porcia* Bill., *Strophomena aurora* Bill., *Strophomena camerata* Con., *Zygospira acutirostra* Hall, *Asaphus canalis* Con., *Cheirurus vulcanus* Bill., *Illæneus crassicauda* Wahl. (?), *Remipleurides schlotheimi* Bill..... 55 "
3. Massive beds crowded with *Orthis costalis* Hall..... 75 "
4. Crinoidal beds containing univalves and the layer of red-spotted marble ; *Columnaria parva* Bill. occurs near the top..... 70 "

Total exposure of *A*..... 223 feet.

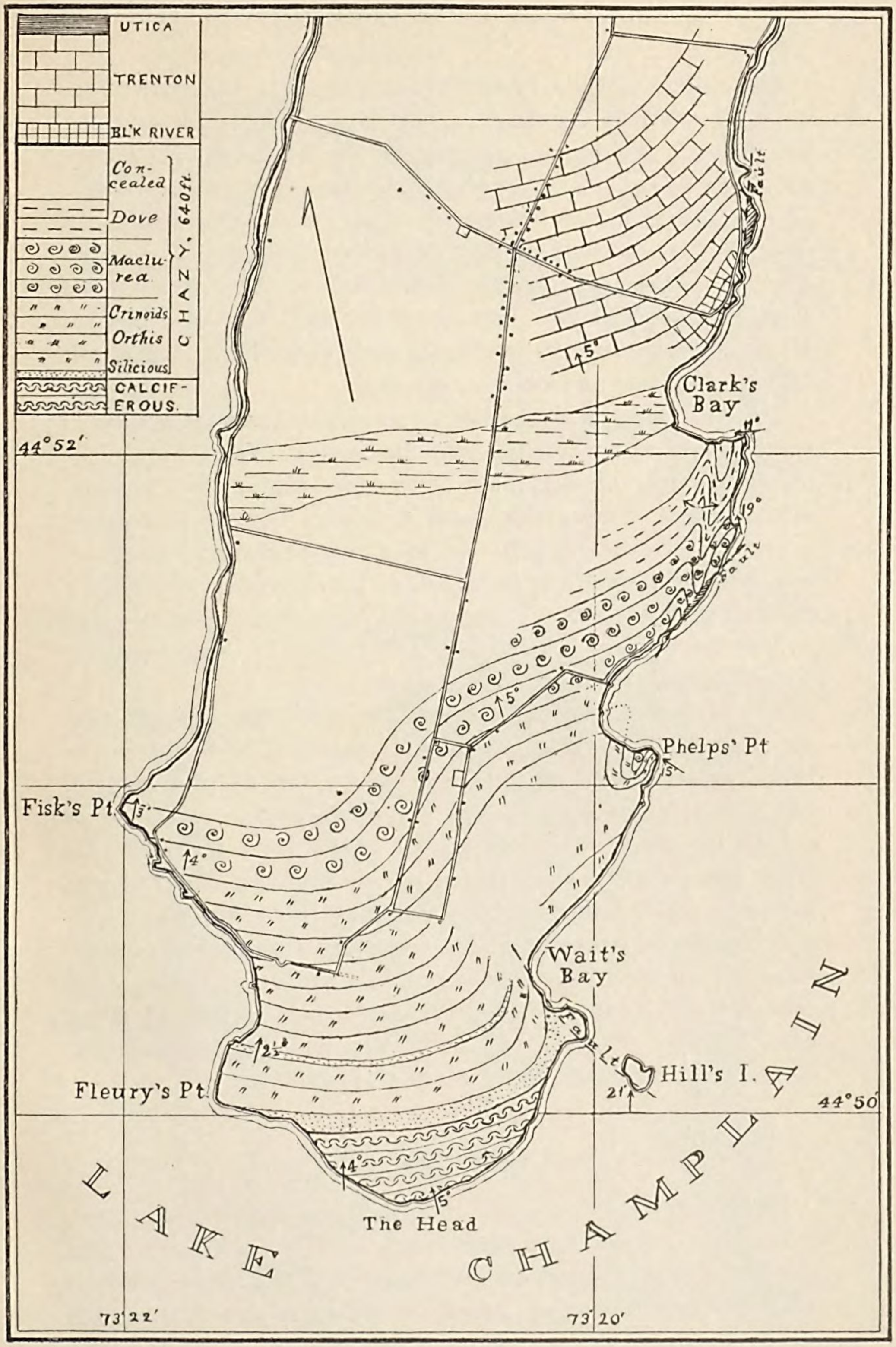
### *Group B (Middle Chazy).*

Bluish-black, massive limestone like *B*, 3, at Valcour Island, containing *Maclurea magna* in abundance, and strata largely filled with *Stromatocerium*. The gray oölitic bed is found here at the base of the group, and the strata at the top are unusually massive, about 150 feet.

### *Group C (Upper Chazy).*

1. Pure, fine-grained, dove-colored limestone with intercalated beds of silicious and dolomitic, iron-gray limestone, containing *Cyrtoceras boycii* Whitf., *Orthoceras titan* Hall, *Placoparia multicostata* Hall, *Lichas champlainensis* Whitf., and undescribed species of *Illænus* and *Bucania*..... 120 feet.
2. Concealed..... 150 "

Total thickness of Chazy at Isle La Motte..... 643 feet.




ISLE LA MOTTE, VT

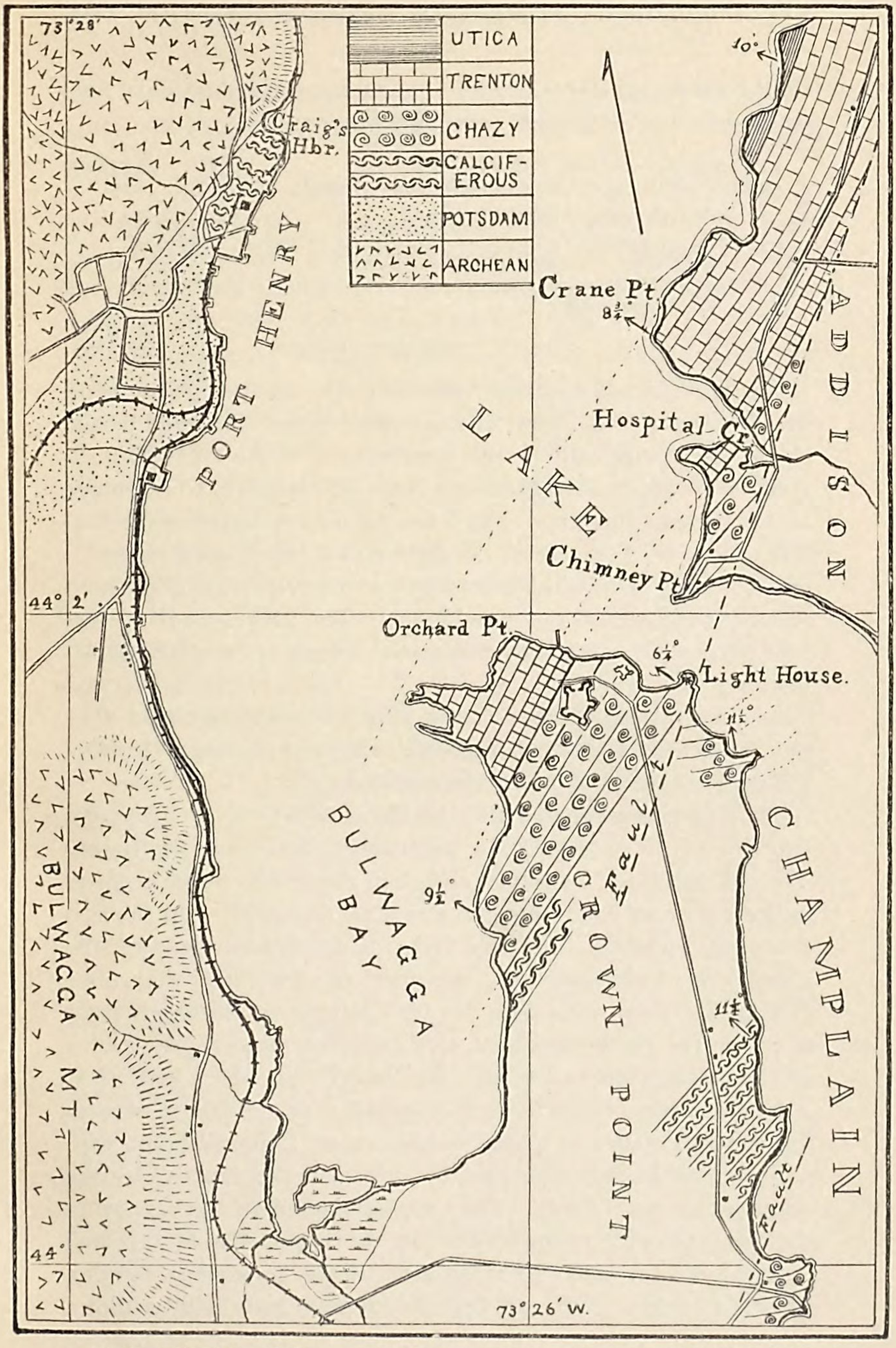
The south end of the island affords excellent opportunities for the study of the Lower Chazy. The rocks are well exposed along the shore, in the interior pastures of the headland (which rises about 100 feet above the lake), and in numerous quarries which have been extensively worked for over seventy-five years. In using the map for field work it should be remembered that the shading indicates the position of the strata on a horizontal plane at the level of the lake. Because of the small dip the exposures of these various strata at *elevated* points should be looked for farther south than indicated on the map.

The east shore of the island shows signs of great disturbance. A fault may be seen running from the head of Wait's Bay across the promontory on the south and farther southeastward across Hill's Island. Half a mile south of Clark's Bay the Utica slate is brought into contact with the Maclurea beds, which are here seen to have been abruptly folded, as is indicated on the map by the zigzag strike and the greatly increased dip. Two hundred rods to the north of Clark's Bay the Utica slate is again seen, but in contact with the Trenton limestone.

To the west of Clark's Bay the rocks have been eroded below the surface of the lake, and a wide marsh extends across the island. To the north of the marsh are seen beds of the Trenton, which may be traced to the east shore, where they are found to overlie the Black River limestone. Away from the shore the strike and the dip of the Trenton are uniform and identical with the strike and the dip of the Chazy to the south of the marsh ; we may, therefore, suppose that the concealed strata are the uppermost beds of the Chazy, which at Chazy village, six miles to the west, and at Valcour and at Grand Isle, consist largely of *Rhynchonella plena*. In fact, boulders of these strata are found on the shore of Isle La Motte to the south of the marsh.

## The Crown Point Section.

Our third map represents the geological outcrop at Crown Point, N. Y., about forty miles south of Valcour Island. The region is one of unusual interest, as we here find representatives of all the formations that appear in the Champlain Valley from




CROWN PT., N.Y., AND VICINITY.

the Archean to the Utica slate. The measures of the Chazy here disclosed are as follows, in ascending order :

| | | |
|---|---|---|
| *A* | 1. Sandstone and slate interstratified | 23 feet. |
| | 2. Impure limestone containing *Orthis platys* Bill | 25 " |
| *B* | Beds containing *Maclurea magna* | 200 " |
| *C* | 1. Dark gray, massive limestone, weathering in darker stripes an inch wide, containing *Bucania*, sp. und | 40 " |
| | 2. Tough, silicious and magnesian rock, passing into a two-foot bed of pure sandstone | 17 " |
| | Aggregate thickness | 305 feet. |

North of Port Henry the Archean gneiss forms high bluffs on the west shore of the lake, and is well exposed for study by the extensive cuttings made in the construction of the D. & H. Railroad. West of the old furnace a large excavation has been made in the Archean limestone, which has been here quarried for flux. The village of Port Henry is underlain by the Potsdam sandstone, resting upon which may be seen the dark magnesian limestone at the base of the Calciferous. The railroad tunnel just west of the Bay State furnace passes through these strata, showing a northeastwardly dip of about 8°. North of the tunnel and extending to Craig Harbor is the pure limestone of *Group B* of the Calciferous, which is here, as well as elsewhere along the lake, a favorite source of flux for the iron-makers.

The higher measures of the Calciferous are to be found on the east side of the Crown Point peninsula. The rocks are largely covered with the Champlain clay, but the fossils would seem to indicate that we have here the strata of *Group D.* On the east shore of Bulwagga Bay we find the uppermost beds of the Calciferous underlying the measures of the Chazy as above described. From Bulwagga Bay the Chazy runs northeastwardly to the end of the promontory, and underlies the extensive ruins of the English fort and of the old French fort—Fort Frederick. Across the lake, which is here contracted to a width of twenty-five or thirty rods, the Chazy re-appears on Chimney Point, with a dip and strike indicating that the beds are continuous with the outcrop on Crown Point. They are terminated on the east by an oblique fault, with a downthrow on the east. The fault is well exposed on the lake shore just east of the Lighthouse ; and a few rods farther south we find the upper Chazy with a dip of

11½° to the north. A similar fault occurs two miles farther south, where the Chazy appears in a downthrow, to the east of the Calciferous.

In the old fosse north of the English fort, near its entrance, may be seen the pure, dove-colored, brittle limestone at the base of the Black River, overlying the stratum of sandstone, which here as well as at Valcour caps the Chazy. The darker limestones of the Black River appear on the shore north of the fort, and were quarried in past years for black marble. Overlying them to the west are the ordinary strata of the Trenton. The Black River limestone may also be seen near the mouth of Hospital Creek, on the Vermont side of the lake, and extends northerly for nearly a mile, until apparently cut off by the oblique fault before mentioned.

To the west of this outcrop of the Black River there is a fine display of the whole of the Trenton limestone—on Crane's Point and at Norton's Bay. Its thickness is found to be 314 feet. To the north for several miles along the shore are exposures of the Utica slate.

In closing, we would call attention to the outcrops of the Chazy formation at Ball's Bay and at Providence Island, as represented in maps to illustrate the Calciferous, heretofore published in the 'Bulletin' of the American Museum of Natural History (Vol. III, pp. 15 and 18).

# INDEX TO VOLUME VIII.

[The names of new genera, species and subspecies, are printed in heavy-faced type.]

---


ACCIPITER nisus, 40.
Adzes, 206.
Ægeria æmula, 139.
albicornis, 136.
aureola, 130.
aureopurpurea, 137.
bassiformis, 133.
bolteri, 134.
brunneipennis, 129.
candescens, 143.
caudata, 116.
consimilis, 133.
corni, 138.
corusa, 140.
culiciformis, 136.
curcurbitæ, 113.
edwardsii, 142.
deceptiva, 128.
decipiens, 141.
emphytiformis, 115.
eupatori, 133.
fulvipes, 135.
geliformis, 145.
giliæ, 128.
hemizoniæ, 130.
henshawi, 135.
hylotomiformis, 127.
hyperici, 129.
imitata, 133.
impropria, 130.
infirma, 133.
inusitata, 134.
kœbelei, 139.
lupini, 130.
lustrans, 133.
madariæ, 130. 132.
mimuli, 130.
morula, 142.
neglecta, 132.
nicotiana, 141.
novaroënsis, 133.
opalescens, 126.
perplexa, 130.
pictipes, 134.
pini, 124.
polistiformis, 122.
præstans, 144.
Ægeria prosopis, 142.
proxima, 136.
pyralidiformis, 147.
pyramidalis, 127.
pyri, 139.
querci, 141.
quinquecaudata, 117.
refulgens, 132.
rubristigma, 141.
rubrofasciata, 134.
sapygæformis, 146.
saxifrigæ, 135.
scitula, 139.
senecioides, 129.
sexfasciata, 133.
tecta, 142.
tricincta, 120.
verecunda, 142.
washingtonia, 130.
(Paranthrene) bassiformis, 133.
Ægeriidæ, 111.
Ægialitis, 31.
Aërolites, catalogue of, in American Museum of Natural History, 154.
Aërosiderites, catalogue of, in American Museum of Natural History, 149.
Aërosiderolites, catalogue of, in American Museum of Natural History, 152.
**Agriocharis,** 274, 288.
ocellata, 274, 287.
Albuna artemisiæ, 129.
denotata, 119.
hylotomiformis, 127.
modesta, 112, 128.
pyramidalis, 127.
pyramidalis coloradensis, 127.
pyramidalis montana, 127.
pyramidalis rubescens, 127.
resplendens, 129.
rileyana, 129.
rutilans, 130.
tanaceti, 127.
torva, 127.

Albuna vancouverensis, 127.
vitrina, 128.
Alcæ, 31.
Alcathoë caudata, 116.
caudatum, 116.
Allen, J. A., alleged changes of color in the feathers of birds without molting, 13–44; note on *Macrogeomys cherrici* (Allen), 45, 46; on mammals collected in Bexar County and vicinity, Texas, by Mr. H. P. Attwater, with field notes by the collector, 47–80; descriptions of new North American mammals, 233–240; list of mammals collected by Mr. Walter W. Granger, in New Mexico, Utah, Wyoming and Nebraska, 1895–96, with field notes by the collector, 241–258; on mammals from the Santa Cruz Mountains, California, 263–270.
Allops, 162, 174.
serotinus, 159, 162, 192.
Amazilia cinnamomea, 284.
yucatanensis, 284.
Amazona albifrons, 286.
Amblycercus holosericeus, 280.
Amulets, Aztec, 203.
Bar, 199, 203.
Bird, 199, 203.
Anas glacialis, 31.
nigra, 26.
Ani, Groove-billed, 285.
Anisacodon, 159, 161.
montanus, 159, 161, 183.
Anoplotherium, 158.
Antelope, 52.
Anthi, 31.
Ant-thrush, Mexican, 284.
Anthus littoralis, 28.
Antilocapra americana, 52.
Antrostomus yucatanicus, 274.
Anvils, 207.
Ardea herodias, 289.
Arenarius, 31.
Armadillo, Nine-banded, 51.
Arremonops rufivirgata striaticeps, 280.
Arrow Heads, 213.
Asaphus canalis, 306, 310.
Atalapha borealis, 70.
cinerea, 70.
Attwater, H. P., see Allen, J. A.
Auk, Razor-billed, 2.
Axe, Battle, 201, 203.
Ceremonial, 199.
Grooved, 206, 218.

Badger, 258.
Mexican, 74.
Balls, 218.
Banner Stones, 199, 200.
Battle Axe, 201.
Bird Wing, 201.
Butterfly, 201.
Circular, 201.
Conical, 201.
Pick, 201.
Rectangular, 201.
Single Arm, 201.
Special, 201.
Triangle Bar, 201.
Bassariscus astutus, 72.
Bat, Golden-backed, 257.
Hoary, 71.
House, 70.
Little Pale, 257.
Red, 70.
Beads, Bone, 213.
Glass, 213.
Shell, 213.
Stone, 213.
Bear, Black, 72.
Beaver, 70.
Bembecia emphytiformis, 115.
flavipes, 119.
marginata, 118, 119.
marginata albicoma, 119.
odyneriformis, 119.
pleciæformis, 118, 119.
rubi, 119.
sequoiæ, 119.
superba, 119.
Beutenmüller, William, critical review of the Sesiidæ found in America, north of Mexico, 111–148; transformations of some North American Hawk-Moths, 291–298.
Bison bison, 53.
Bison, American, 53.
Blackbird, Pueblo, 281.
Wedge-billed, 280.
Blarina brevicauda, 244, 257.
Boas, Franz, see Teit, James.
Bobolink, 42, 44.
Bob-white, Yucatan, 289.
Bolboporites americanus, 306.
Brainerd, Ezra, and Seely, Henry M., the Chazy Limestone of Lake Champlain, 305–315.

Brontops, 161, 174.
dispar, 159, 161, 188.
robustus, 159, 161, 187.
Brontotherium, 160.
gigas, 159, 160, 161, 175.
ingens, 159, 161, 182.
Bucania, sp., 306, 310, 314.
Bunting, Painted, 22, 279.
Reed, 14.
Bunts, 216.

Calabashes, Shell, 217.
Calidris arenaria, 2.
Callothrus robustus, 280.
Camerella breviplicata, 310.
(?).costata, 305.
Campephilus principalis, 274.
Canis latrans, 75, 242, 258.
lupus (? nubilis), 75.
nubilis, 258.
Cardinal, Yucatan, 279.
Cardinalis cardinalis yucatanicus, 279.
Caribou, Barren-Ground, 234.
Greenland, 234.
Newfoundland, 234.
Woodland, 234.
Carmenta fraxini, 124.
minuta, 147.
nigra, 147.
pyralidiformis, 147.
ruficornis, 147.
sanborni, 147.
Castor canadensis, 70.
Cat, Civet, 72.
Leopard, 80.
Catharista atrata, 287.
Catharistes papa, 24.
Cathartes aura, 287.
Celts, 205, 218.
Ceophlœus scapularis, 285.
Ceratiocaris, 299.
**monroei,** 301.
**poduriformis,** 302.
Ceratomia undulosa, 296.
Chachalacca, Yucatan, 288.
Chaffinch, 15.
Chapman, Frank M., the changes of plumage in the Dunlin and Sanderling, 1–8; on the changes of plumage in the Snowflake (*Plectrophenax nivalis*), 9–12; notes on birds observed in Yucatan, 271–290.
Charadrii, 31.
Charadrius auratus, 28.
Chat, Yellow-breasted, 277.
Cheiurus polyodorus, 306.
vulcanus, 310.
Chettusia gregaria, 34.
Chickaree, 257.
Chipmunk, Antelope, 255.
Colorado, 256.
Say's, 255.
Wahsatch, 256.
Wortman's, 255.
Chisels, 206.
Chlorostilbon canaveti, 284.
Cissolopha yucatanica, 282.
Club Stones, 199.
Cœreba, sp., 24.
Colinus nigrogularis, 289.
Columba flavirostris, 287.
Columbigallina passerina pallescens, 287.
rufipennis, 287.
Columnaria parva, 310.
Colymbus rufogularis, 31.
Conepatus mapurito, 72.
Conoryctes, 259, 260.
Conoryctidæ, 260, 262.
Contopus brachytarsus, 283.
Conurus aztecus, 286.
carolinensis, 274.
Coracias garrulus, 31.
Cores, 216.
Cottontail, Arizona, 245.
Granger's, 246.
Sage, 245.
Coyote, 75.
Cowbird, Red-eyed, 280.
Crotophaga sulcirostris, 285.
Cups, Paint, 207.
Cutters, 218.
Cyanecula, 27.
Cyclorhis flaviventris yucatanensis, 278.
Cyclorhis, Yucatan, 278.
Cynomys leucurus, 242, 254.
ludovicianus, 70, 254.
Cyrtoceras boycii, 310.

Deer, Black-tailed, 52.
Mule, 52.
Virginia, 52.
Dendrocincla anabatina, 284.
homochroa, 284.
Dendroica virens, 277.
Dendrornis flavigastra, 284.
Diconodon, 159, 161, 178, 183.
Dicotyles angulatus, 54.
Didelphis marsupialis californica, 51.
marsupialis virginiana, 51.
Diplacodon, 166, 174.

Diploconus, 174.
amplus, 159, 189, 193.
Discoidals, 199, 208.
Discs, 199.
Engraved, 214.
Small, 209.
Dives dives, 281.
Dog, Prairie, 70.
White-tailed Prairie, 254.
Dolichonyx oryzivorus, 42, 44.
Dorcelaphus hemionus, 52.
virginianus, 52.
Douglass, A. E., a table of the geographical distribution of American Indian relics in a collection exhibited in the American Museum of Natural History, New York, with explanatory text, 199-220.
Dove, Mexican Ground, 287.
Rufous Ground, 287.
White-fronted, 287.
White-winged, 287.
Drills, 199, 214.
Dryobates scalaris parvus, 285.
Dunlin, 1, 15.

ECTOCIUM, 83.
Ectoganus, 259, 261.
Emberiza lapponica, 31.
nivalis, 31.
Empidonax minimus, 283.
**Entomocaris**, 299.
**telleri**, 280.
Eohippus, 81, 82.
pernix, 81, 82.
validus, 81, 82.
Epihippus, 92, 93.
Erethizon epizanthus, 246.
Euhagena nebraskæ, 116.
Eumomota superciliaris, 285.
Euphonia hirundinacea, 279.
Euphonia, Bonaparte's, 279.
Euprotogonia plicifera, 106, 110.
puercensis, 105, 110.

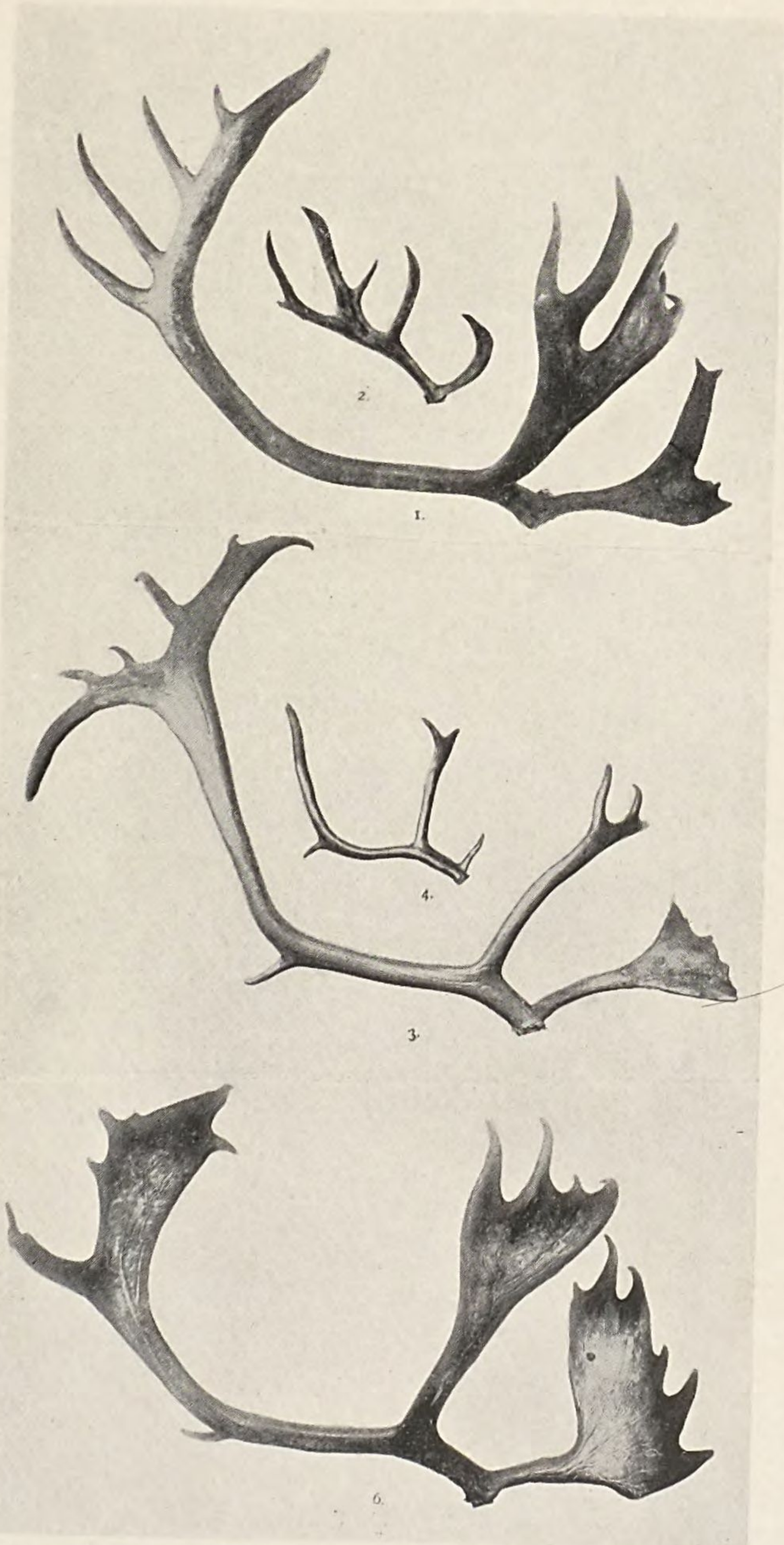
FALCO rufigularis, 286.
sparverius, 286.
Falcon, Red-throated, 286.
Fatua denudata, 124.
palmii, 122.
Felis concolor, 80.
onca, 80.
pardalis, 80.
(Lynx) vulgaris maculatus, 78.
Flageolets, 217.
Flakers, 216.
Fleshers, 199, 206.
Flutes, 200.
Flycatcher, Ash-throated, 283.
Giraud's, 283.
Large-billed, 283.
Least, 283.
Yucatan, 283.
Fox, Gray, 78.
Red, 76.
Fuligula rufina, 36.

**GAËA**, 115.
emphytiformis, 115.
solituda, 115.
**Ganodonta** (new suborder), 259.
Geomys cherriei, 45.
heterodus, 46.
texensis, 57.
Geothlypis trichas, 277.
Glaucidium phalænoides, 286.
Gnatcatcher, Blue-gray, 276.
Godwit, Barred-tailed, 17.
Black, 17.
Gopher, Texas, 57.
Gorgets, 199, 201.
Shell, 203.
Stone, 201.
Gouges, 206.
Granatellus sallæi boucardi, 278.
Granger, Walter W., see Allen, J. A.
Grouse, Red, 41.
Gull, Black-headed, 15, 22.
Herring, 17.
Little, 2.

HÆMATOPUS, 31.
Haplacodon, 162, 174.
angustigenis, 159, 162, 184.
Hare, Attwater's Swamp, 80.
Prairie, 244.
Sage, 245.
Texas Wood, 56.
Harmonia morrisoni, 124.
pini, 124.
Harpes antiquatus, 306.
ottawaënsis, 306.
sp. und., 306.
Havelina, 54.
Hawk, Crying, 286.
Rufous-winged, 286.
Sparrow, 286.
Heads, Arrow, 213.
Spear, 214.
Hematites, 199, 210.
Hemiganus, 259, 260.
Hemiura brevicauda, 277.
Heptodon, 81, 84, 85.
calciculus, 86.



Rangifer terræNovæ.



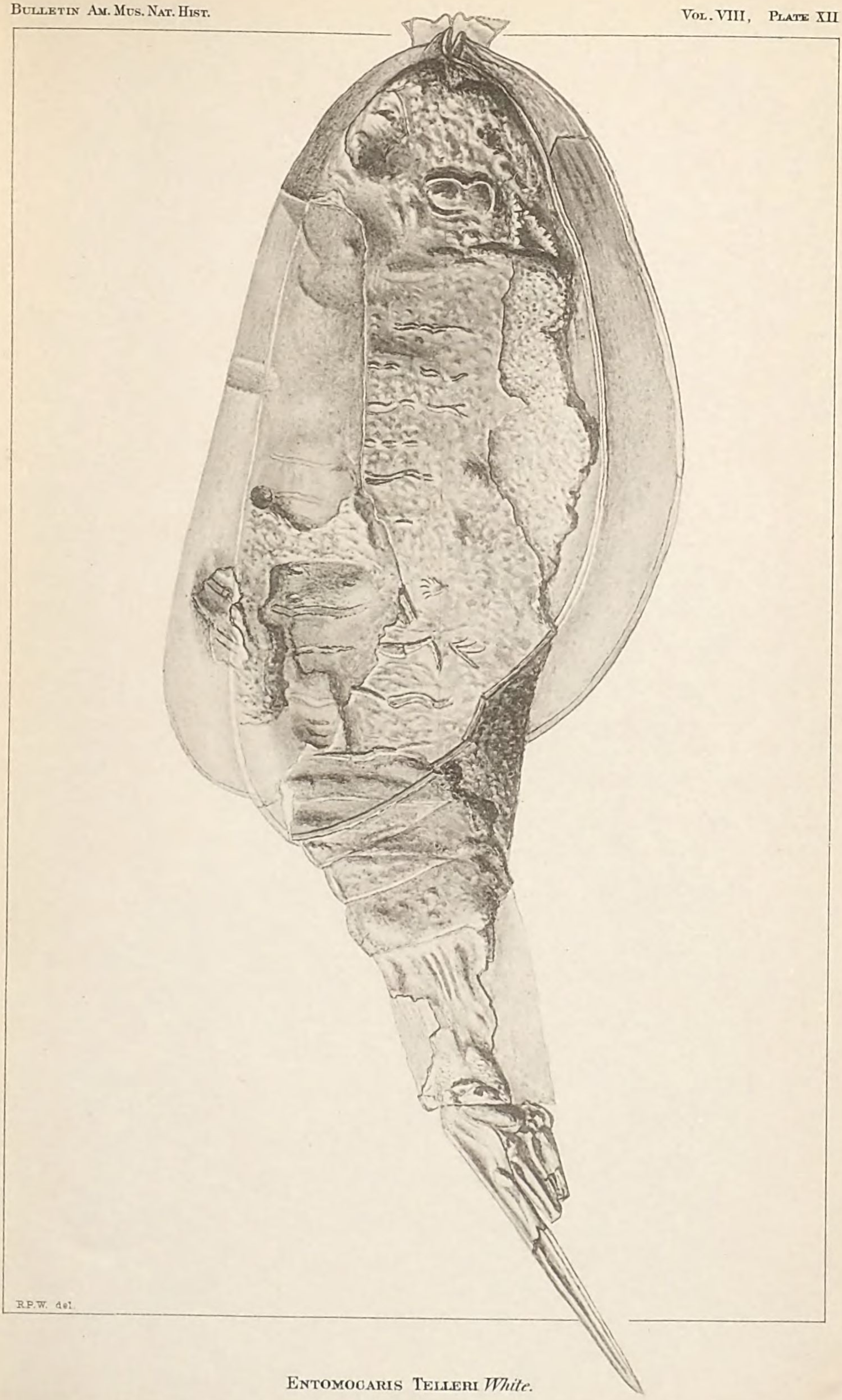

Antlers of Caribou.

Figs. 1, 2. Rangifer terrænovæ, ♂, ♀.
" 3, 4. " grœnlandicus, ♂, ♀.
" 6. " tarandus, ♂.

## EXPLANATION OF PLATE XII.

*Entomocaris telleri.*

The figure is the only nearly entire individual observed, and is of natural size. It shows the right and left sides of the carapace a little displaced vertically, but preserving the outlines almost entire, the outer half having the posterior margin slightly faulted so as to throw it about a third of an inch out of line with the upper impression, which is the continuation of it, while the inner half is concealed over the same region by the overlying abdomen. The remains of the swimming feet are seen scattered along beneath the crust of the carapace, and show through its surface. The projecting outline in front of the carapace represents a thin film of crust which probably does not pertain to the animal, unless it may be a part of the mandibles.




ENTOMOCARIS TELLERI *White.*

## EXPLANATION OF PLATE XIII.

*Ceratiocaris monroei.*

Fig. 1.—View of part of the carapace showing all but the anterior outline, and preserving much of the crust. The abdomen is seen, also preserving the test over the greater portion of its surface, and some indications of slender, bifurcating limbs to seven of the segments within the carapace. The caudal plate and spines shown in the figure may belong to the same individual, but they are on a lower layer of the shaly rock.

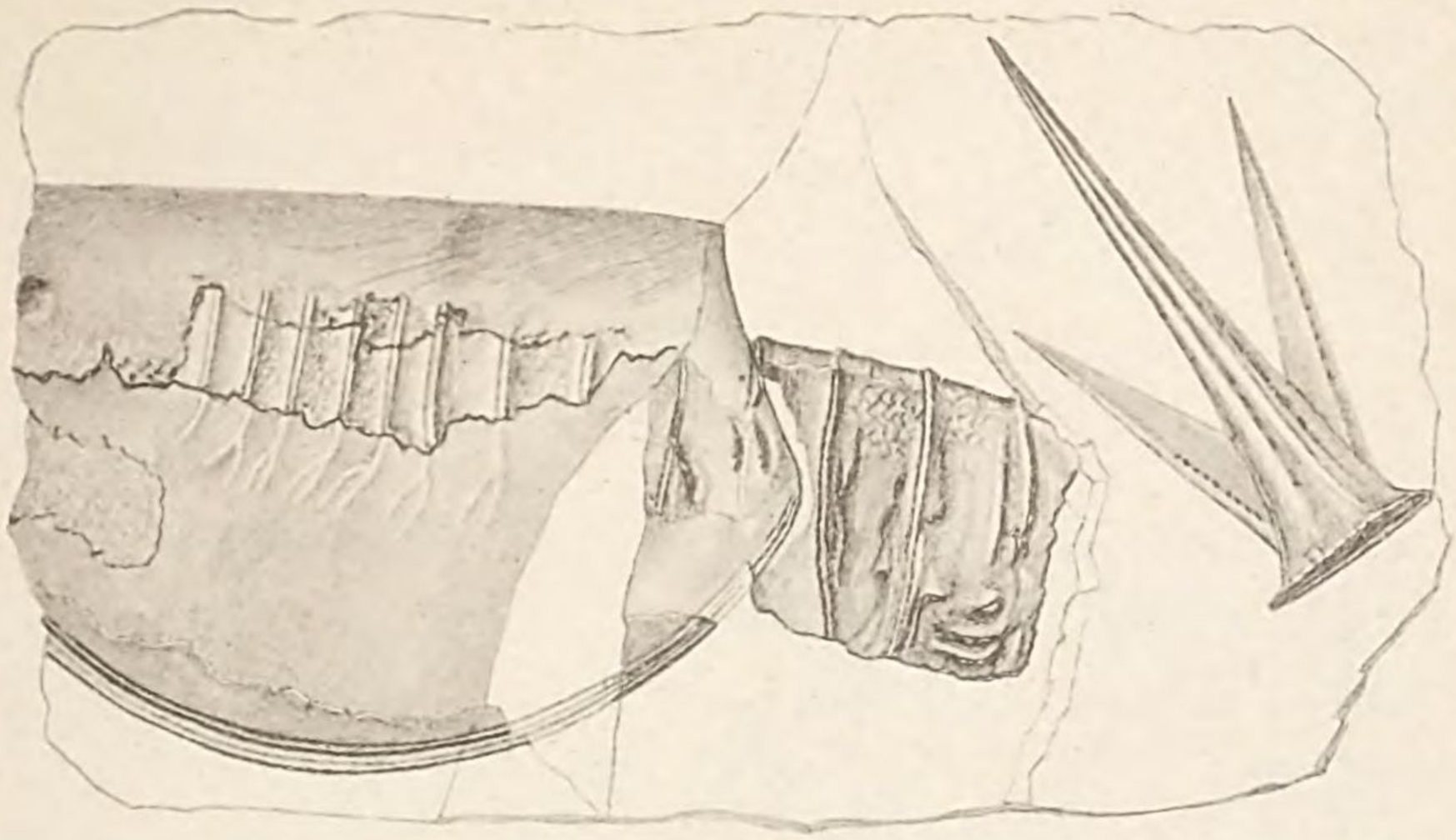
Fig. 2.—An abdomen with fourteen joints and the telson and spines, also a fragment of the border of the carapace and mandible. The depressed line along the abdomen is supposed to represent the intestinal canal.

Fig. 3.—View of another specimen showing part of a carapace, mandible, body segments and telson, with remains of swimmerets.

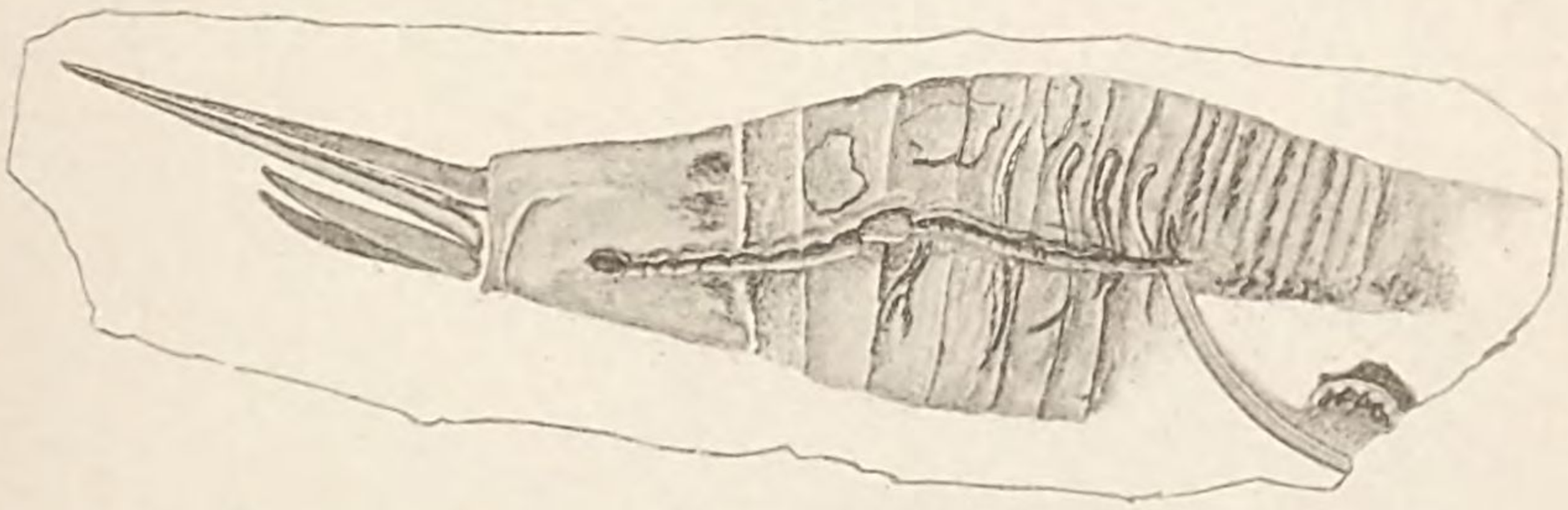
Fig. 4.—View of a fragment of a carapace showing the anterior rostral sinus. The carapace is folded on one side of the center, shortening the front side so as to make the two parts appear quite unequal.

Fig. 5.—An imperfect mandible in which the masticating tubercles have been broken. Enlarged two diameters.

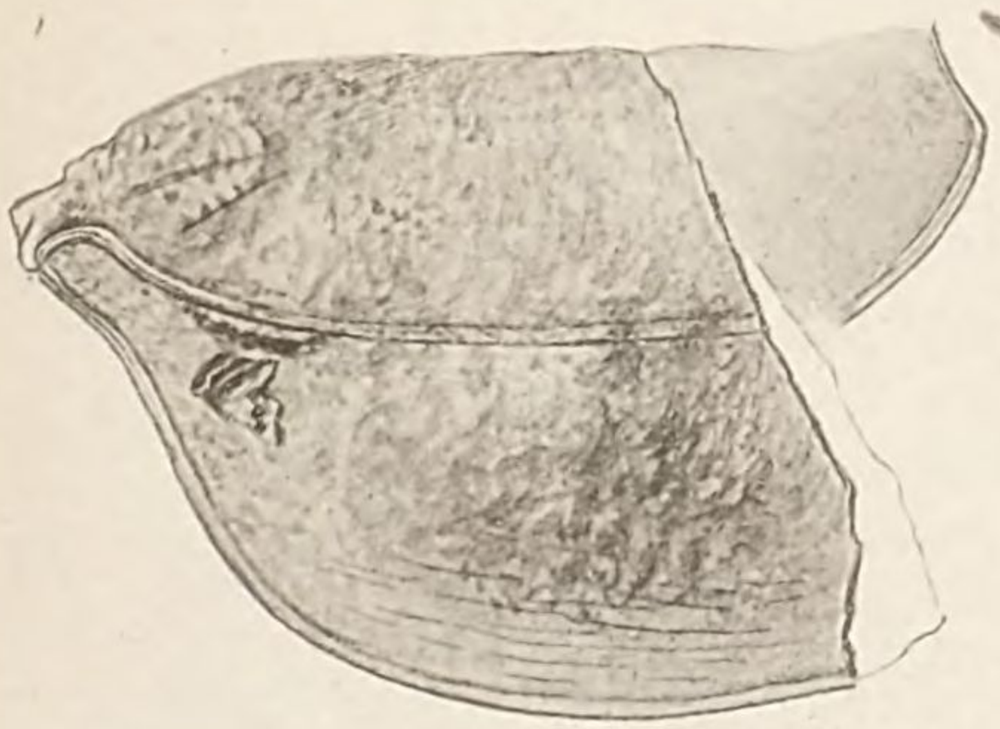
1



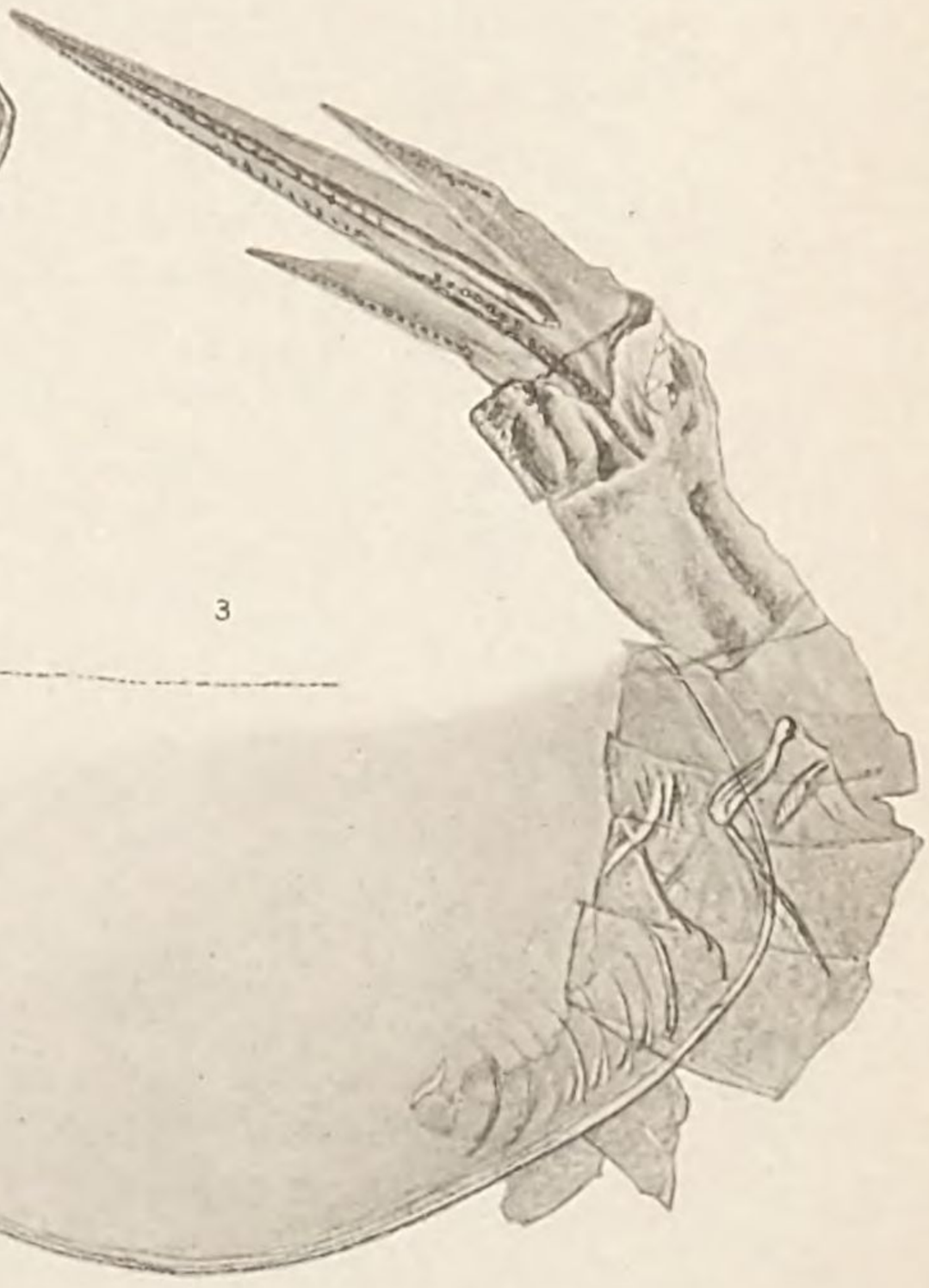
2



4



3



5




R.P.W. del.

## EXPLANATION OF PLATE XIV.

*Entomocaris telleri?*

Fig. 1.—View of a left mandible supposed to belong to this species. The manubrium has been ruptured and distorted. Enlarged two diameters.

Fig. 2.—View of a nearly entire right mandible. Enlarged two diameters.

*Ceratiocaris monroei.*

Fig. 3.—View of a right mandible showing the prevailing form seen. Enlarged two diameters.

Fig. 4.—View of the outer face of a form of mandible seldom found. Natural size.

Fig. 5.—View of an abdomen showing fifteen segments, with the imprint of several of the swimmerets and of what may have been the intestinal canal. Little of the crust is preserved, but the matrix preserves the imprint of the peculiar markings of the surface very distinctly.

Fig. 6.—Caudal plate and telson with the appendages flattened laterally, and showing the articulation very perfectly.

Fig. 7.—View of another specimen flattened obliquely and showing pointed margins to the last body segment.

Fig. 8.—Enlargement of the zigzag surface ornamentation of the body segments.

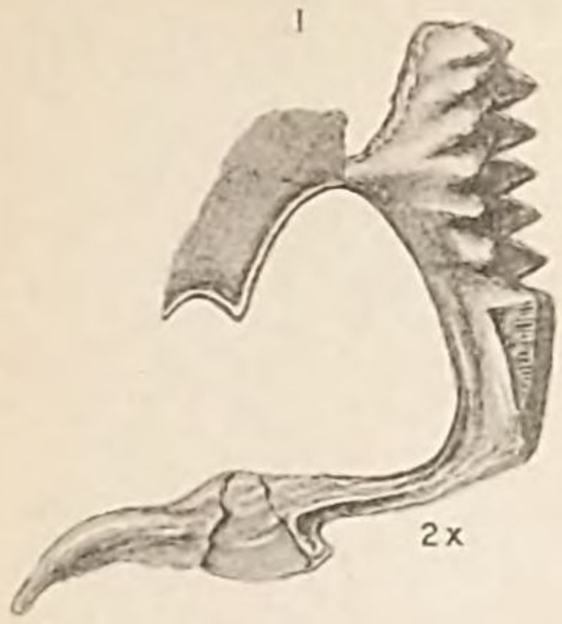
*Entomocaris telleri?*

Fig. 9.—View of the terminal segment and caudal plate and spines which may belong to this species.

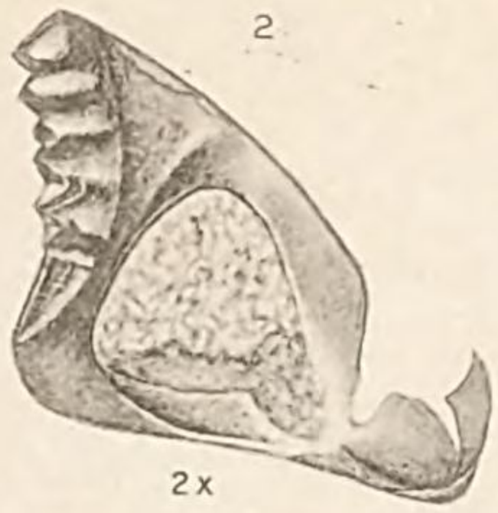
*Ceratiocaris poduriformis.*

Fig. 10.—View of the imprint of the type specimen, which retains part of the crust. Natural size.

1




2




3




5



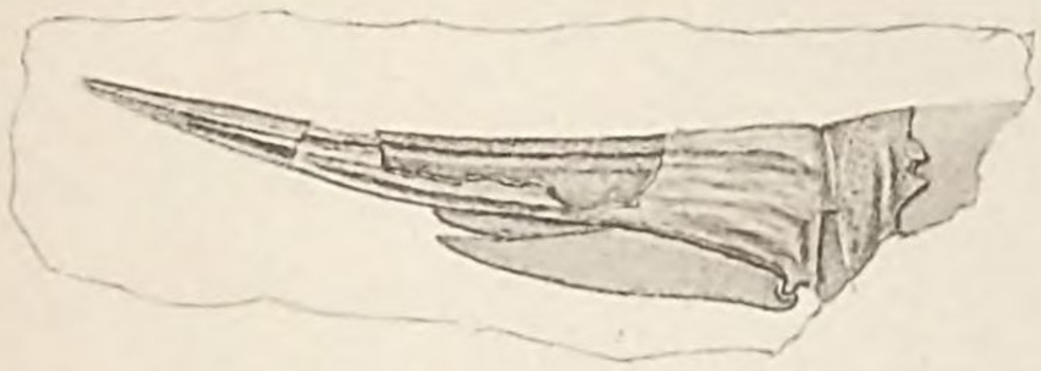
8



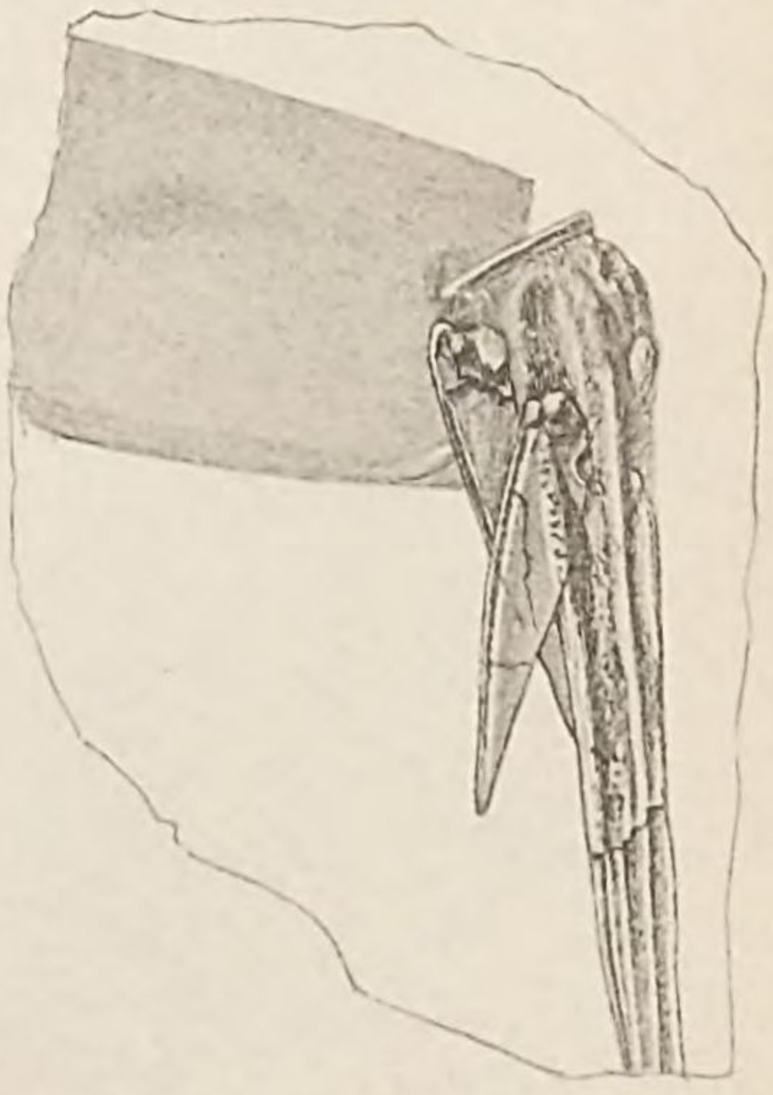
4



6



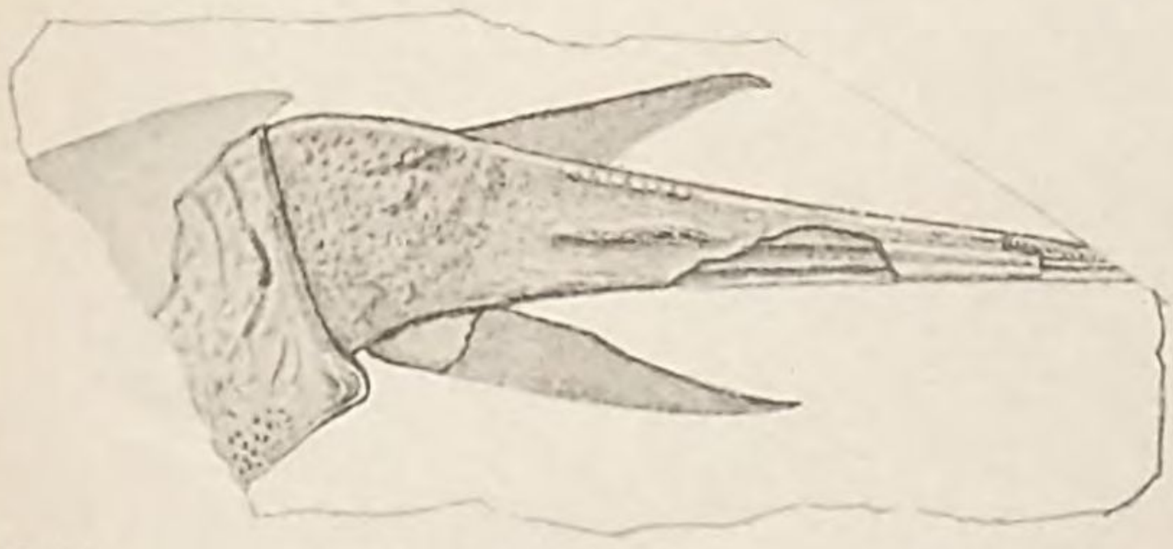
9



10



7



R.P.W. del

Heptodon posticus, 86.
singularis, 86.
ventorum, 86.
Heron, Great Blue, 289.
Herpetotheres cachinnans, 286.
Hoes, 207.
Hovey, E. O,, catalogue of Meteorites in the collection of the American Museum of Natural History, to July 1, 1896, 149–155.
Hummingbird, Cabot's, 284.
Canivet's, 284.
Cinnamon, 284.
Prevost's, 284.
Hyracotherium, 81, 82, 84, 91.
angustidens, 99.
craspedotum, 93, 94, 97, 110.
**cristatum,** 93, 94, 96, 110.
index, 82, 93, 94, 98, 110.
tapirinum, 93, 94, 110.
vasacciense, 82, 94, 98, 110.
venticolum, 82, 100.
(Pliolophus) cristonense, 93, 103, 110.
(Pliolophus) **montanum,** 93, 102, 110.

ICTERIA virens, 277.
Icterus auratus, 274, 281.
baltimore, 24.
galbula, 22.
giraudi, 280.
gularis, 281.
icterocephalus, 24.
spurius, 22, 24.
Illænus arcturus, 306.
bayfieldii, 306.
crassicauda, 310.
incertus, 306.
Implements, Boat-shaped, 205.
Bone, 204.
Bronze, 217.
Shell, 204.
Stone, 204.
Indian Relics, American, in collection of A. E. Douglass, 199–220.
Indian rock paintings, 227–230.

JACKRABBIT, Rio Grande, 55.
Jaguar, 80.
Jay, Brown, 282.
Guatemala Green, 281.
Yucatan Blue, 282.

KINGBIRD, Mexican, 284.
Knives, 215.
Knives, Flake, 216.
Knot, 7.

LAGOPUS alpina, 32.
scoticus, 40, 41.
subalpina, 32.
Lampornis prevosti, 284.
Lari, 31.
Larunda palmii, 148.
solituda, 115.
Larus atricilla, 8.
minutus, 8, 29.
ridibundus, 37.
Leidyotherium, 159, 160.
Leptæna fasciata, 306.
Leptotila fulviventris brachyptera, 287.
Lepus aquaticus attwateri, 80.
arizonæ, 244, 245.
callotis, 55.
campestris, 242, 244.
grangeri, 244, 246.
melanotis, 55.
merriami, 55.
nuttalli, 242, 245.
sylvaticus bachmani, 56.
sylvaticus grangeri, 246.
sylvaticus nuttalli, 245.
trowbridgei, 263.
Lestrides, 31.
Lichas champlainensis, 310.
minganensis, 306.
Limonites, 213.
Limosa melanura, 36.
rufa, 36.
Limosæ, 31, 36.
Lingula huronensis, 306.
Lion, Mountain, 80.
**Lissopleura,** 232.
æquivalvis, 232.
Lituites, sp., 306.
Lumps, Mineral, 218.
Paint, 218.
Lynx rufus, 258.
rufus var. maculatus, 78.
texensis, 78.
vulgaris maculatus, 78.
Lynx, Bay, 258.
Texas, 78.

MACE, 200.
Mace Head, 200.
Maclurea magna, 306, 310, 314.
Mallard, 14.
Mauls, 207.
Grooved, 207.
Megaceratops acer, 159, 160.
heloceras, 159, 160.

Megacerops coloradensis, 159, 160, 175.
Megarhynchus pitangua, 283.
Melanerpes dubius, 285.
rubriventris, 274, 285.
Melittia amœna, 113.
curcurbitæ, 113.
gloriosa, 114.
grandis, 114.
satyriniformis, 113.
snowii, 112, 114.
Melopelia leucoptera, 287.
Meniscotherium, 262.
Menodon, 158.
Menodus, 158, 159, 161, 174.
angustigenis, 159, 161, 184.
dolichoceras, 159, 161, 185.
platyceras, 159, 161, 185.
selwynianus, 159, 193.
syceras, 159, 178, 193.
tichoceras, 159, 161.
Menops, 161.
varians, 159, 161, 189.
Mephitis mesomelas, 73.
Merops apiaster, 31.
Meteorites, catalogue of, in American Museum of Natural History, 149–155.
Microtus austerus, 244, 248.
edax, 268.
haydenii, 248.
?longicauda, 244, 249.
pallidus, 242 (in error).
pauperrimus, 248.
pennsylvanicus, 244, 249.
sp. inc., 242, 244, 249.
Miobasileus, 160.
ophryas, 160.
Mniotilta varia, 277.
Mole, Silvery, 257.
Texas, 71.
Monticulipora, 306.
Mormon, 31.
Mortars, 207.
Motacilla lugubris, 28, 40.
Motacillæ, 31.
Motmot, Red-backed, 285.
Mound Relics, 213.
Mouse, Attwater's Cliff, 65.
Dyche's Harvest, 67, 253.
Eastern Grasshopper, 253.
Eastern Meadow, 249.
Fulvous White-footed, 251.
Hayden's Meadow, 248.
House, 59.
Idaho Grasshopper, 253.
Jumping, 248.
Lacey's Harvest, 235.
Long-tailed Meadow, 249.
Maximilian's Pocket, 247.
Nebraska Pocket, 247.
Northern White-footed, 252.
Pallid Meadow, 248.
Prairie Meadow, 248.
Rio Grande Harvest, 66.
Silky Cliff, 251.
Taylor's, 65.
Texas White-footed, 64.
True's Cliff, 251.
Yellow Pocket, 58.
Muscicapa atricapilla, 21.
collaris, 31.
Mus decumanus, 59,
musculus, 59, 269.
Myiarchus cinerascens, 283.
lawrencei, 283.
yucatanensis, 283.
Myiozetetes texensis, 283.

Neotoma cinnamomea, 241, 242, 244, 249.
fuscipes, 264.
micropus, 60.
mexicanus, 60.
orolestes, 244, 245, 250.
rupicola, 249, 250.
Neürotrichus gibbsii, 269.
Notiosorex crawfordi, 71.
Nuclei, 216.
Numenius arquata, 36.
Nyctidromus albicollis merrilli, 285.
Nyctinomus brasiliensis, 70.

Objects, Copper, 217.
Hematite, 217.
Iron Ore, 217.
Ocelot, 80.
Oidemia nigra, 26, 27.
Onychodectes, 259, 260.
Onychomys leucogaster, 244, 253.
leucogaster brevicauda, 242, 243, 244, 253.
Opossum, 51.
Texas, 51.
Oriole, 22.
Black-backed, 281.
Giraud's, 280.
Golden, 281.
Ornaments, Alloy, 217.
Bone, 215.
Breast, 200.
Bronze, 217.
Gold, 217.
Shell, 215.
Stone, 215.

Orohippus, 92, 93, 108, 110.
Ortalis vetula pallidiventris, 288.
Orthis, 305, 306, 310.
costalis, 306, 310.
disparilis, 306.
perveta, 306.
platys, 306, 314.
porcia, 310.
Orthoceras, 305, 306.
titan, 310.
Osborn, Henry Fairfield, the cranial evolution of Titanotherium, 157–197.
Owl, Ferruginous Pigmy, 286.

PACHYNOLOPHUS, 92.
desmaresti, 92.
sideroliticus, 92.
Paint-cups, 213.
Palæocystites tenuiradiatus, 306.
Palæotherium, 158, 159.
bairdii, 158, 159.
giganteum, 158, 159.
proutii, 158, 159.
**Palmia,** 123.
præcedens, 123.
Panther, 80.
Parauque, Merrill's, 285.
Parharmonia fraxini, 124.
græfi, 125.
pini, 124.
Paroquet, Carolina, 274.
Passerina ciris, 279.
Pebbles, Natural, 213.
Peccary, Texas, 54.
Pendants, 212.
Pear-shaped, 218.
Perodipus longipes, 242, 244, 246.
ordii, 57.
richardsoni, 247.
Perognathus californicus, 263.
fasciatus, 242, 247.
fasciatus flavescens, 244, 247.
flavus, 58, 237.
**mearnsi,** 237.
paradoxus spilotus, 58.
Peromyscus attwateri, 65.
auripectus, 242. 244, 251.
californicus, 266.
canus, 64.
gilberti, 267
michiganensis, 238.
michiganensis **pallescens,** 238.
rufinus, 244, 252.
texanus, 64, 238.
texanus arcticus, 243, 244. 252.
Peromyscus texanus gambelii, 267.
texanus nebrascensis, 242, 244, 250.
truei, 251.
(Baiomys) taylori, 65.
Pestles, 207.
Petrochelidon fulva, 273.
Pewee, Short-legged, 283.
Phemonoë quinquecaudata, 117.
Phenacodus, 83.
Phœnicothraupis rubicoides, 279.
Picks, 207.
Pigeon, Red-billed, 287.
Pipes, 199, 210.
Piranga roseigularis, 274, 279.
Placoparia (Calymene) multicostata, 306.
multicostata, 310.
Platypus niger, 27.
Plectrophenax nivalis, 9, 42.
Pliolophus, 83, 84, 102.
vulpiceps, 83.
Plover, Golden, 7, 17, 20.
Plummets, 212, 218.
Podiceps minor, 29.
Podosesia fraxina, 125.
syringæ, 125.
Polioptila cærulea, 276.
Polishers, 199, 212.
Porcupine, Yellow-haired, 246.
Procellariæ, 31.
Procyon lotor hernandezii, 72.
**Protorohippus,** 92, 104.
venticolus, 93, 105, 108, 110.
Psilorhinus mexicanus, 282.
Psittacotherium, 259, 261.
Ptarmigan, 15.
Putorius brasiliensis frenatus, 74.
Pyrrhotænia achillæ, 144.
animosa, 146.
behrensii, 143.
coloradensis, 176.
elda, 143.
eremocarpi, 144.
floridensis, 145.
fragariæ, 143.
geliformis, 145.
helianthi, 143.
meadii, 144.
orthocarpi, 143.
polygoni, 144.
præstans, 144.
sapygæformis, 146.
subærea, 146.
texana, 145.
wittfeldii, 145.

QUIPPUS, 217.

RACCOON, 72.
Rangifer arcticus, 234.
caribou, 234.
grœnlandicus, 234.
tarandus caribou, 233.
tarandus grœnlandicus, 233.
tarandus terrænovæ, 235.
**terrænovæ,** 233, 234, 235.
Rat, Bad-lands, 250.
Brown, 59.
Fulvous Wood, 249.
Moki Kangaroo, 246.
Mountain Wood, 250.
Ord's Kangaroo, 57.
Texas Cotton, 62.
Reamers, 214.
Redstart, 278.
Remipleurides schlotheimi, 310.
Reithrodontomys dychei, 67, 244, 252.
**laceyi,** 235.
longicauda, 268.
mexicanus intermedius, 66, 235.
Rhynconella æquivalvis, 231.
plena, 306.
Rupornis ruficauda, 286.

SALTATOR atriceps, 279.
Sanderling, 1.
Sandpiper, Swiss, 15.
Sannina exitiosa, 117.
pacifica, 126.
uroceriformis, 117, 126.
**Sanninoidea,** 126.
exitiosa, 112, 126.
opalescens, 126.
Saunina uroceripennis, 117.
Saville, M. H., the Temple of Tepotzlan, Mexico, 221–226.
Saxicola rubetra, 31.
Scalops argentatus, 244, 257.
texanus, 71.
Scapanus townsendii, 270.
Sciapteron admirandus, 123.
cupressi, 121.
denotata, 119.
dollii, 122.
græfi, 125.
palmii, 122.
polistiformis, 122.
præcedens, 123.
robiniæ, 120.
scepsiformis, 121.
seminole, 122.
simulans, 121.
tricincta, 120.
Sciuropterus volans, 67.
Sciurus fossor, 269.
hudsonicus, 244, 257.
niger limitis, 67.
Scoter, 26.
Scrapers, 215.
Seals, Aztec, 217.
Seely, Henry M., see Brainerd, Ezra.
Seiurus aurocapillus, 277.
Sesia acerni, 138.
albicornis, 136.
aureopurpurea, 137.
authraciformis, 112.
asilipennis, 124.
bassiformis, 133.
bibiopennis, 112.
brunneipennis, 129.
candescens, 143.
caudata, 116.
chrysidiformis, 112.
corni, 138.
corusca, 140.
culiciformis, 112.
culiciformis **americana,** 136.
decipiens, 141.
edwardsii, 142.
fulvipes, 135.
madariæ, 132.
mellinipennis, 129.
mimula, 130.
morula, 142.
neglecta, 132.
nigella, 147.
nomadiæformis, 112.
novaroënsis, 133.
pictipes, 134.
prosopis, 142.
pyri, 139.
querci, 141.
refulgens, 132.
rileyana, 129.
rubristigma, 141.
rubrofasciata, 134.
rutilans, 130.
saxifrigæ, 135.
scitula, 139.
tecta, 142.
tepheri, 137.
tipuliformis, 138.
verecunda, 142.
xiphidiæpennis, 112.
Sesiidæ, 111.
Setophaga ruticilla, 278.
Shrew, Crawford's, 71.
Eared, 257.
Hayden's, 257.
Short-tailed, 257.

Sigmodon hispidus texianus, 62.
Sinkers, 212.
Skunk, Bare-nosed, 72.
Indianola Striped, 73.
Texas, 73.
White-backed, 72.
Smerinthus myops, 297.
Snowflake, 9, 42.
Solenopora compacta, 306.
Sorex californicus, 269.
montereyensis, 269.
personatus, 244, 257.
personatus haydeni, 244, 257.
Sospita quinquecaudata, 117.
Spades, 208.
Sparrow, Striped-crowned, 280.
Spermophile, Kennicott's, 254.
Pale Striped, 254.
Small Striped, 254.
Wyoming, 254.
Spermophilus buckleyi, 67.
couchi, 68.
elegans, 242, 243, 254.
grammurus buckleyi. 67.
grammurus couchi, 68.
mexicanus, 69.
obsoletus, 244, 254.
tridecemlineatus, 69.
tridecemlineatus pallidus, 244, 254.
tridecemlineatus parvus, 241, 242, 254.
Sphærexochus parvus, 306.
Sphinx drupiferarum, 291.
kalmiæ, 293.
lucitiosa, 292.
plebeius, 295.
Spilogale indianola, 73.
Squirrel, Black Rock, 67.
Flying, 67.
Pecos Fox, 67.
Stamps, 217.
Aztec, 217.
Stenopora, 306.
Sternæ, 31.
Stelgidopteryx serripennis, 278.
Stones, Club, 210.
Cupped, 207.
Hammer, 207, 218.
Nut, 207.
Perforated, 210.
Strepsilas, 31.
Stromatocerium, 310.
Strophomena aurora, 310.
camerata, 310.
incrassata, 306.
Stylinodon, 259.
Stylinodontidæ, 260.
Sylvania mitrata, 278.
Sylvia cinerea, 31.
curruca, 31.
hortensis, 31.
nisoria, 31.
suecica, 31.
Symborodon, 160, 174.
acer, 178.
altirostris, 159, 161, 178, 179.
bucco, 159, 176, 179.
heloceras, 179.
hypoceras, 159, 161, 180.
ophryas, 177.
trigonoceras, 159, 161, 180.
torvus, 159, 160, 176.
(Miobasileus) ophyras, 159.
Systemodon, 81, 84.
**primævus,** 89.
protapirinum, 89.
semihians, 85, 89.
Swallow, Rough-winged, 278.

Tamias lateralis, 243, 255.
leucurus, 242, 244, 255.
minimus consobrinus, 241, 242, 256.
pricei, 268.
quadrivittatus, 243, 244, 256.
wortmani, 241, 242, 255.
Tanager, Black-headed, 279.
Rose, 279.
Rose-throated, 279.
Tarsa bombyciformis, 124.
denudata, 124.
Tatusia novemcincta, 51.
Taxidea taxus, 258.
taxus berlandieri, 74.
Teit, James, a rock painting of the Thompson River Indians, British Columbia, edited by Franz Boaz, 227–230.
Teleodus, 162, 174.
avus, 159, 194.
Telmatotherium, 166.
Tepoztlan, temple of, 221–226.
Thamnophilus doliatus mexicanus, 284.
Thomomys bottæ, 263.
clusius, 242, 246.
Thryothorus albinucha, 276.
maculipectus canobrunneus, 276.
Tirista admiranda, 123.
admirandus, 123.
argentifrons, 123.
Titanops, 161, 174.
curtus. 159, 162, 189.
elatus, 159, 162, 189.

Titanotherium (Rhinocerus) americanus, 158, 159.
Titanotherium, the cranial evolution of, 157–197.
Titanotherium, 158.
acer, 164, 169, 171, 178.
altirostris, 179.
americanum, 158, 174.
amplum, 164, 193.
angustigenis, 184.
avum, 194.
bairdii, 174.
bucco, 167, 171, 179.
coloradense, 171, 175, 196.
curtum, 189.
dispar, 189.
dolichoceras, 164, 169, 185.
elatum, 164, 167, 171, 183, 189, 196.
giganteum, 174.
gigas, 160, 175.
heloceras, 164, 167, 171, 179, 196.
hypoceras, 183.
ingens, 164, 169, 171, 182, 196.
maximum, 158, 159, 174.
montanum, 183.
ophryas, 177.
platyceras, 164, 167, 185, 196.
proutii, 158, 159, 174.
**ramosum,** 164, 167, 194, 196.
robustum, 164, 167, 187, 196.
selwynianus, 193.
serotinum, 169, 192.
syceras, 193.
tichoceras, 179, 184, 196.
trigonoceras, 164, 167, 180, 196.
torvum, 164, 176.
varians, 189.
Tityra personata, 284.
Totem, 200,
Totani, 31.
Tringa alpina, 2.
alpina pacifica, 3.
subarquata, 36.
variabilis, 36
Trochilium apiforme, 118.
californicum, 118.
caudatum, 116.
ceto, 113.
denudatum, 124.
fraxini, 125.
gallivorum, 139.
grandis, 114.
hospes, 139.
luggeri, 121.
Trochilium minimum, 118.
pacificum, 118.
polistiformis, 122.
pyri, 139.
scitula, 139.
tibiale, 118.
(Paranthrene) bassiformis, 133.
(Sciapteron) simulans, 121.
Tubes, 210.
Turkey, Ocellated, 287.
Tyrannus melancholicus, 284.

URIÆ, 31.
Urocyon cinereo-argenteus, 78.
Ursus americanus, 72.

VANELLUS cristatus, 31.
gregarius, 34, 36.
Vespamima sequoiæ, 119.
Vespertilio **chrysonotus,** 242, 257.
ciliolabrum, 242, 257.
**incautus,** 239.
sp., 71, 239.
Vireo flavifrons, 278.
noveboracensis, 278.
ochraceus, 278.
Vireo, Ochraceous, 278.
White-eyed, 278.
Yellow-throated, 278.
Vulpes fulvus, 76.
Vulture, Black, 287.
Turkey, 287.

WANDS, 200.
Warbler, Black-and-white, 277.
Black-throated Green, 277.
Blue-throated, 26.
Boucard's, 278.
Hooded, 278.
Weapon, Ceremonial, 200.
Weasel, Bridled, 74.
Whetstones, 212.
Whistles, 217.
Whitfield, R. P., description of a new genus of fossil Brachiopod from the Lower Helderberg limestones, 231, 232.
Whorles, Spindle, 209, 210.
Wolf, Gray, 258.
Lobo, 75.
Prairie, 258.
Timber, 75, 258.
Woodhewer, 284.
Woodpecker, Cabot's, 285.
Delattre's, 285.
Ivory-billed, 274.

Woodpecker, Swainson's, 285.
Uxmal, 285.
Wortman, J. L., species of *Hyracotherium* and allied Perissodactyls from the Wahsatch and Wind River Beds of North America, 81–110; *Psittacotherium*, a member of a new and primitive suborder of the Edentata, 259–262.
Wren, Cabot's, 276.
Temax, 276.
Yucatan, 277.

XANTHOURA cyanocapilla, 281.
Xanthoura guatemalensis, 281.
luxuosa, 281.

YELLOW-THROAT, Maryland, 277.
Yucatan, birds observed in, 271–290.

ZAPUS, sp. inc., 244, 248.
Zenaida zenaida, 273.
Zenodoxus canescens, 148.
heucheræ, 148.
maculipes, 148.
palmii, 148.
potentillæ, 148.
Zygospira acutirostra, 310.

## ERRATA.

Page 54, line 6, for '**Dycotyles**' read '**Dicotyles.**'
" 75, line 18, for 'Great Dame' read 'Great Dane.'
" 242, last line, for 'Microtus pallidus' read 'Microtus pauperrimus.'
" 288, last line, for ἀγριος read ἄγριος.

# PUBLICATIONS

OF THE

# American Museum of Natural History.

---

## BULLETIN.

| | | |
|---|---|---|
| VOLUME I, 1881–86 | Price, | $4.25 |
| " II, 1887–90 | " | 3.50 |
| " III, 1890–91 | " | 3.00 |
| " IV, 1892 | " | 3.00 |
| " V, 1893 | " | 3.00 |
| " VI, 1894 | " | 3.00 |
| " VII, 1895 | " | 3.00 |
| "VIII, 1896 | " | 3.00 |

*Separate numbers of the Bulletin may be obtained at the following rates:*

VOL. I, No. 1, 30 cts.; No. 2, out of print; No. 3, $1.00; No. 4, out of print; No. 5, 45 cts.; No. 6, 45 cts.; No. 7, out of print; No. 8, 80 cts.

VOL. II, No. 1, 85 cts.; No. 2, $1.30; No. 3, $1.00; No. 4, 55 cts.

VOL. III, No. 1, $1.50; No. 2, $1.50.

(The publication of the Bulletin in Numbers was discontinued with the close of Vol. III.)

## MEMOIRS.

| | | |
|---|---|---|
| VOLUME I, PART 1, 1893 | Price, | $1.50 |
| " " " 2, 1895 | " | 1.50 |

Address,

ANTHONY WOODWARD,

Librarian.

*American Museum of Natural History,*

77th Street and 8th Avenue, New York City.

Please acknowledge to the Librarian,

AMERICAN MUSEUM OF NATURAL HISTORY,

77th Street and 8th Avenue,

New York City.

*EXCHANGES SOLICITED.*

J. Strobl, Buchbinde
München, Aventinstr. 1

BSB Bayerische StaatsBibliothek
MDZ Münchener DigitalisierungsZentrum Digitale Bibliothek

Bulletin of the American Museum of Natural History

Bd.: 8. 1896

New York, NY 1896

H.nat. 95 f-8
urn:nbn:de:bvb:12-bsb11810720-3